Exhibit B

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BY E-FILE

The Honorable Mary Pat Thynge
United States Magistrate Judge
United States District Court
U.S. Courthouse
844 King Street
Wilmington, DE 19801

Re: Honeywell International, Inc. et al. v. Apple Computer, Inc. *et al.*
D. Del., C.A. Nos. 04-1338, 04-1337, 04-1536

Dear Magistrate Judge Thynge:

We write on behalf of co-defendants Epson Imaging Devices, Fuji Photo Film Co, Ltd., now FUJIFILM Corporation, Fuji Photo Film U.S.A., Inc., now FUJIFILM U.S.A., Inc., Hitachi Displays, Ltd., Optrex America, Inc., Samsung SDI Co., Ltd., Samsung SDI America, Inc., Seiko Epson Corp., Wintek Corp. and Wintek Electro-Optics Corporation ("Manufacturer Defendants") to oppose Plaintiffs' ("Honeywell") application to take discovery of the stayed Customer Defendants, allegedly to seek evidence to support its claim of commercial success, a secondary consideration in the analysis of the obviousness of the claimed invention. Such discovery is only permitted if reasonably calculated to lead to admissible evidence, and then only if it is not unduly burdensome on the stayed Customer Defendants. Fed R. Civ. P. 26(b)(1) and (2). Honeywell has failed to satisfy this threshold requirement.

Honeywell correctly cites the Federal Circuit precedent that requires a nexus between the claimed invention and the commercial success sought to be proved. Grimm 3/2/07 letter at first

half of 4. "[Commercial] success must be shown to have in some way been due to the nature of the claimed invention, as opposed to other economic and commercial factors unrelated to the technical quality of the patented subject matter." *Cable Electric Prods., Inc. v. Genmark Inc.*, 770 F.2d 1015, 1027 (Fed. Cir. 1985). Where Honeywell goes wrong is in relying on two improper and incorrect presumptions, that the success of every "Accused Product" and "Accused Module" is attributable to the claimed "invention", and that every such product and module infringes claim 3 of the '371 patent. Strip away these presumptions and examine the facts and it becomes clear that the discovery sought of the Customer Defendants cannot lead to admissible evidence.

I. Honeywell's Requested Discovery Focuses On Advantages of Structures In The Prior Art And Will Not Lead To Admissible Evidence

Not every sale of a product which includes a patented component supports, or is even relevant to, a finding of commercial success. "[I]f the feature that creates the commercial success was known in the prior art, the success is not pertinent." *Ormco Corp. v. Align Technology, Inc.*, 463 F.3d 1299, 1312 (Fed. Cir. 2006). The same is true if commercial success is the result of unclaimed features. *Id.* "[T]he asserted commercial success of the product must be due to the merits of the claimed invention beyond what was readily available in the prior art." *J. T. Eaton & Co. v. Atlantic Paste & Glue Co.*, 106 F.3d 1563, 1571 (Fed. Cir. 1997), *see also, In Re Paulsen,* 30 F.3d 1475, 1482–83 (Fed. Cir. 1994) (commercial success of product was attributable to aspects of claims in prior art and thus was accorded no weight).

Honeywell has argued that the benefits obtained by the '371 patent technology are "a brighter, cleaner display, longer battery life and lower weight." Grimm 3/2/07 letter at 9. However, these benefits are the result of structures that were already known in the prior art more than a year before the filing date of the application for the '371 patent (July 9, 1992). A copy of the '371 patent is annexed as Exhibit 1. Honeywell relinquished claims to these structures during prosecution of the '371 patent, and cannot recapture them in this case.

The application for the '371 patent was filed with very broad claims, not limited to a liquid crystal panel or lens arrays. Ex. 2 at 14. Upon rejection of these broad claims, Honeywell amended the application to present an independent claim 10, which read:

> 10. A display apparatus comprising;
> a light source;
>
> a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and
>
> first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source though said lens arrays and said liquid crystal panel.

Ex. 3 at 2. This claim differs from the '371 patent claim 3 only in the recitation in claim 3 of the moiré minimizing technique of rotating at least one of the two lens arrays to provide a "slight misalignment" between the lenslets of the lens array and the liquid crystal panel (Ex. 1 at col. 6, lines 27-42), a limitation which was claimed in application dependant claim 9. Ex. 3 at 1.

In an Office Action dated May 6, 1993 (Ex. 4 at 1), the Examiner ruled that application claim 10 was anticipated by U.S. Patent No. 5,161,041 ("Abileah et al."; Ex. 5), which was based on an application filed April 26, 1990. Honeywell acquiesced in the finding of the Examiner by combining application claims 9 and 10 to form what became claim 3 of the '371 patent. Ex. 6. Abileah et al. teach two crossed lens arrays between a liquid crystal panel and a light source. Ex. 5 at FIG. 6. Abileah et al. list the advantages of their new LCD backlight in essentially the same terms as Honeywell now claims for the invention of claim 3, namely:

> a bright uniform image of high contrast and capable of being viewed over a wide viewing angle, while maintaining a narrow profile and minimizing power consumption and thermal inconveniences.

Ex. 5 at col. 4, lines 26-29. Abileah et al repeatedly characterize their invention as providing improvements in brightness and energy efficiency:

> In order for electronic displays to gain increased acceptance in military and avionic applications, the backlighting of flat panel displays, and particularly active matrix liquid crystal displays, **must be improved in light efficiency** and reliability. In order for a full color liquid crystal display to possess acceptable contrast under high ambient lighting conditions, the backlighting arrangement **must be bright**. While current backlighting systems have the requisite light output, they still require high power (on the order of 2.4 watts/square inch) and a depth dimension of about two inches. In contrast thereto, **the backlight assembly of the instant invention consumes only about 1.2 watts/square inch of power** with a depth dimension of only about one inch.

Ex. 5 at col. 7, lines 5-15 (emphasis added).

Rotation of the lens array, the only feature of claim 3 not taught in Abileah et al., contributes to eliminating moiré, and not to the enhancement of brightness and energy efficiency of the module. Ex. 1 at col. 4, lines 26-34; col. 5, lines 16-28.

Honeywell's justification for the requested discovery of the stayed Customer Defendants focuses on advantages of LCD modules which are attributable to the prior art, and cannot be considered as evidence of commercial success. *See, supra, Ormco Corp., J. T. Eaton, Paulson.* As such it is not reasonably calculated to lead to the discovery of admissible evidence and should not be permitted.

Furthermore, Honeywell claims that the patented invention produces longer battery life and lower weight have no basis in the '371 patent. Nowhere does the '371 patent describe these features as attributes of the invention. In fact, Honeywell's patent does not even discuss consumer electronics. The only "application" discussed in the patent is aircraft cockpit displays (the same application noted in Abileah et al, *see supra*), and the object of the invention is "to provide a tailored variation of luminance with viewing angle" to focus the light of the display in a particular viewing angle. Ex. 1 at col. 1, lines 40-45. Thus, to the extent the commercial success of Customer Defendants' products may be connected to energy efficiency, longer battery life, or lower weight, these attributes cannot support the non-obviousness of the '371 patent. *See Amazon.com, Inc. v. Barnesandnoble.com, Inc.*, 239 F.3d 1343, 1366 (Fed. Cir. 2001) (evidence

that invention solved certain problem was irrelevant to non-obviousness when "this problem is not even mentioned in the [ ] patent.").

As Honeywell points out, the specification of the '371 patent describes which structural features result in the benefits identified by Honeywell, namely, enhanced brightness and energy efficiency. Indeed, the portion of the '371 patent relied upon by Honeywell states that inserting a lens array between the light source and the liquid crystal panel provides the benefits of increased energy efficiency and increased luminance. Ex. 1 at col. 3, lines 15-36. The portion of the '371 patent specification cited by Honeywell as explaining the benefits of the patent describes an *unclaimed* embodiment. An embodiment having a single lens array provides the benefits of energy efficiency and brightness, whereas the claims of the '371 patent are limited to modules having multiple lens arrays. Thus, even assuming that the benefits alleged by Honeywell and the '371 patent were not found in the prior art, they are provided by an unclaimed feature and, as such, commercial success based on those benefits is irrelevant to validity of the '371 patent. *Ormco Corp.*, 463 F.3d at 1312 ("if the commercial success is due to an unclaimed feature of the device, the commercial success is irrelevant").

II. Honeywell Has Failed To Demonstrate The Necessary Nexus Between Claim 3 And The Customer Defendants' Products.

The Federal Circuit has ruled that: "if the patented invention is only a component of a commercially successful machine or process - the patentee must show prima facie a legally sufficient relationship between that which is patented and that which is sold." *Demaco Corp. v. F. Von Langsdorff Licensing Ltd.*, 851 F.2d 1387, 1392 (Fed. Cir. 1988). In the present case, to demonstrate commercial success based on the end products rather than the LCD modules (the accused products), Honeywell must establish both (1) that the commercial success of the end products are attributable to certain characteristics of the LCD modules (brightness and energy consumption), and (2) that the brightness and energy consumption of the LCD modules are attributable to use of the claimed invention within the modules, as opposed to other embodiments or the prior art. Honeywell fails to make either showing.

In no way does Honeywell suggest how the success of a portable consumer product, such as a digital still camera, a cell phone, a laptop or the other myriad of portable consumer products sold by the Customer Defendants, is attributable to the brightness of the LCD or the weight of the battery, as opposed to the many other features of such devices, both technical (e.g., CPU power, memory volume, camera lens, mobile phone antenna and software) and non-technical (e.g., aesthetic design, advertising, price, sales channel). As discussed above, there is no nexus between the commercial success of the liquid crystal modules at issue and the "invention" of claim 3 of the '371 patent.

The commercial success of the Customer Defendants' Products is even further removed from the alleged success of the Manufacturer Defendants' modules, which are the products at issue. Honeywell cannot maintain that commercial success is unique to LCD modules that contain the accused features. Honeywell's own analysis of the modules within end products successful enough to be considered resulted in only about fifty percent being deemed by Honeywell to infringe. September 9, 2005 Transcript at 22-23, Ex. 7. Thus, by Honeywell's own admission, the fifty percent of defendants' commercially successful products deemed not to infringe must owe their commercial success to features not claimed in the '371 patent. There can be no nexus between the claimed invention and commercial success of the end products when the end products are commercially successful regardless of whether they make use of the accused modules. Where commercial success is attributable to unclaimed features and features found in the prior art, such commercial success cannot be considered. *See, supra, Ormco Corp., J. T. Eaton, Paulson.* The existence of such other features makes Honeywell's proof of the requisite nexus implausible.

The requested discovery is hardly limited. It takes three pages to describe and is, on its face, unduly burdensome on the stayed Customer Defendants at this stage of this case. Given the lack of nexus between the advantages and sales Honeywell seeks to discover and the claimed invention, the failure to explain why evidence adduced from the Manufacturer Defendants is

insufficient, and the existence of non-infringing structures which may have been incorporated in the Customer Defendants' products, it is submitted that Honeywell has failed to demonstrate a need for the discovery sufficient to justify modifying the stay. The requested discovery defeats the purpose of the stay and unduly burdens the Manufacturer Defendants, who would need to monitor the discovery.

Respectfully,

/s/ Philip A. Rovner

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PAR/mes/783007
Enc.

cc: All counsel of record – by ECF

1.

U.S. PATENT NO. 5,280,371

US005280371A

United States Patent [19]

McCartney, Jr. et al.

[11] Patent Number: 5,280,371

[45] Date of Patent: Jan. 18, 1994

[54] **DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY**

[75] Inventors: **Richard I. McCartney, Jr.**, Scottsdale; **Daniel D. Syrold**, Glendale; **Karen E. Jachimowicz**, Goodyear, all of Ariz.

[73] Assignee: **Honeywell Inc.**, Minneapolis, Minn.

[21] Appl. No.: **911,547**

[22] Filed: **Jul. 9, 1992**

[51] **Int. Cl.**[5] **G02F 1/133**
[52] **U.S. Cl.** **359/40**; 359/69
[58] **Field of Search** 359/69, 40, 41

[56] **References Cited**

U.S. PATENT DOCUMENTS

4,416,515	11/1983	Fumada et al.	359/69
5,052,783	10/1991	Hamada	359/41
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5,128,783	7/1992	Abileah et al.	359/40
5,161,041	11/1992	Abileah et al.	359/40

FOREIGN PATENT DOCUMENTS

0068400	10/1977	Japan	359/69
2-14822	8/1990	Japan	359/69

OTHER PUBLICATIONS

IBM Corp., "Polarized backlight for liquid crystal display", IBM Technical Disclosure Bulletin, vol. 33, No. 1B, Jun. 1990, pp. 143-144.

Primary Examiner—William L. Sikes
Assistant Examiner—Huy Mai
Attorney, Agent, or Firm—Dale E. Jepsen; A. Medved

[57] **ABSTRACT**

A display apparatus including a light source, a liquid crystal panel, and one or more directional diffuser lens arrays disposed therebetween provides a tailored variation of luminance with viewing angle, a uniform variation of luminance with viewing angle within a first predetermined range of viewing angles and a concentration of light energy within a second predetermined range of viewing angles.

3 Claims, 11 Drawing Sheets

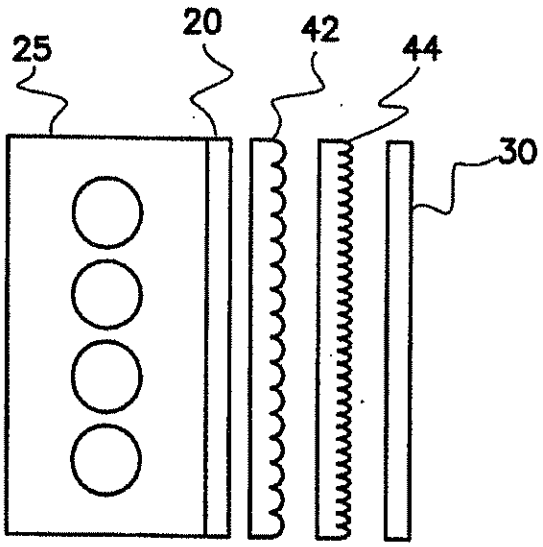


Fig. 1
PRIOR ART

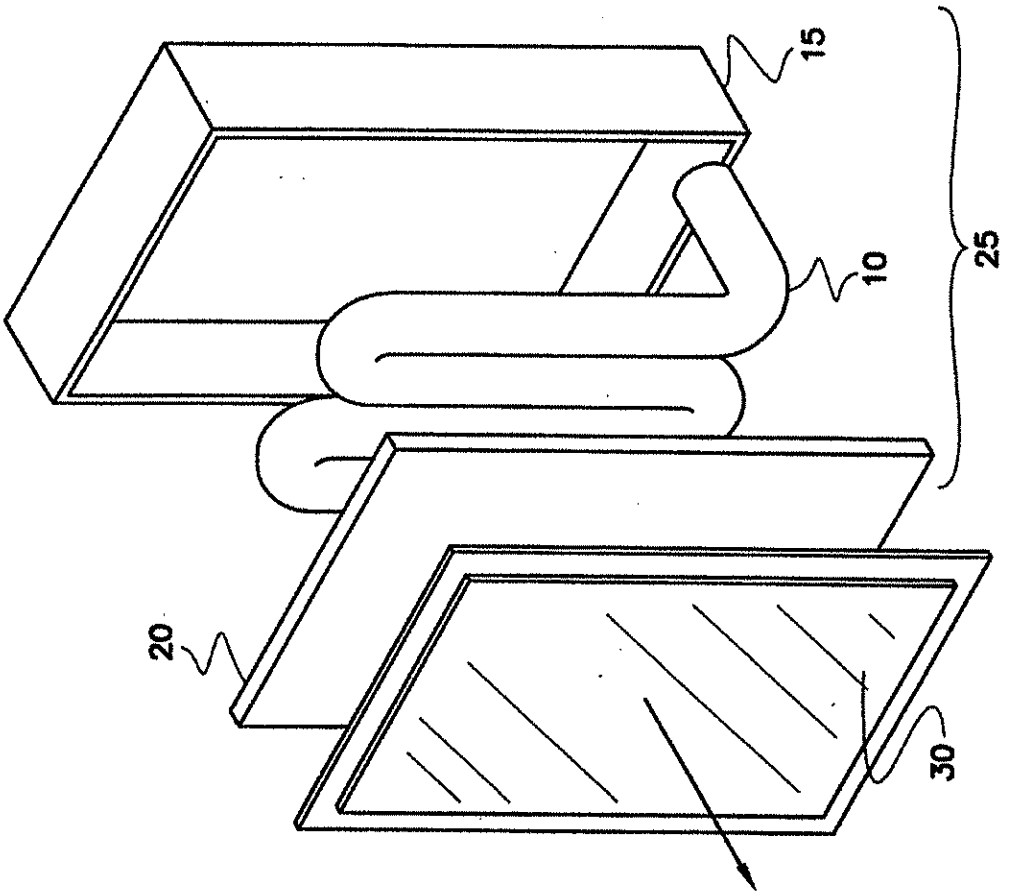
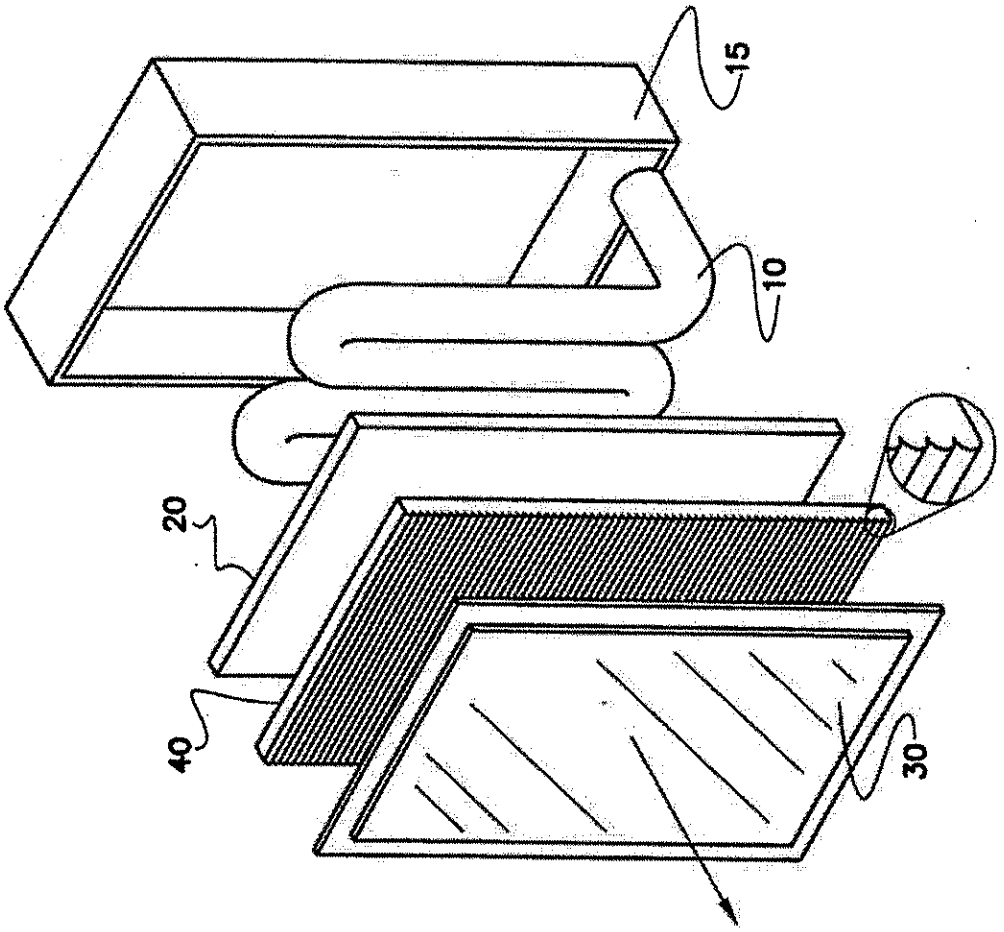
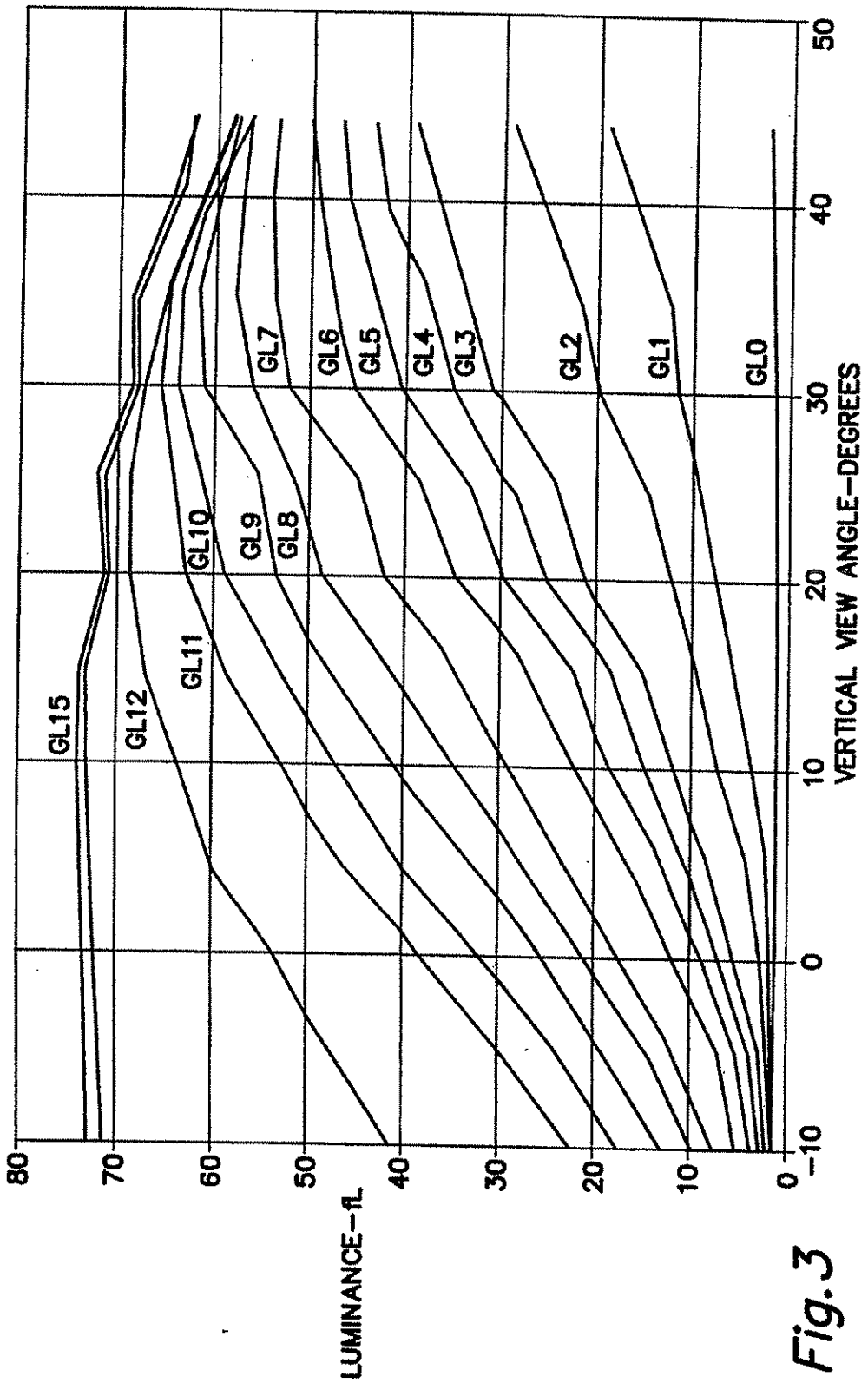


Fig.2

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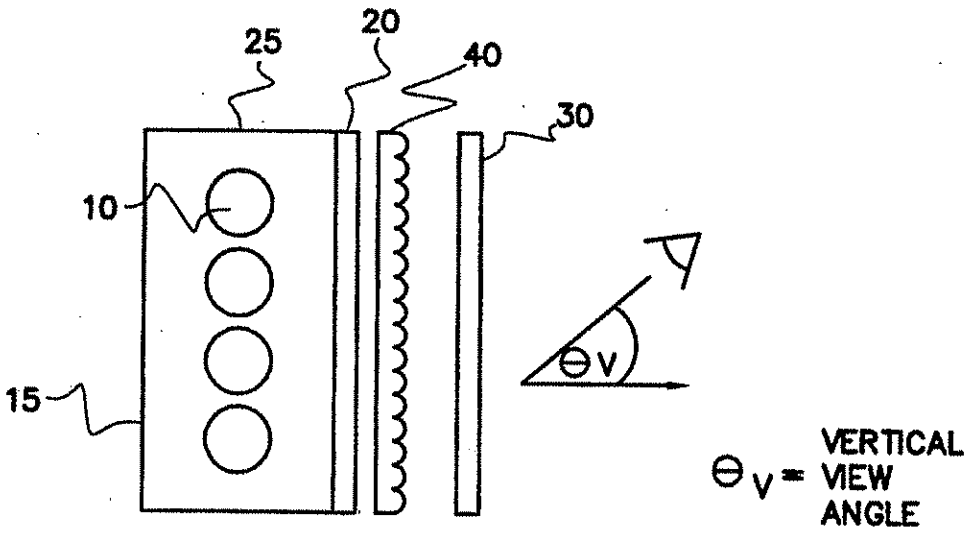
VERTICAL VIEW ANGLE-DEGREES

Fig. 3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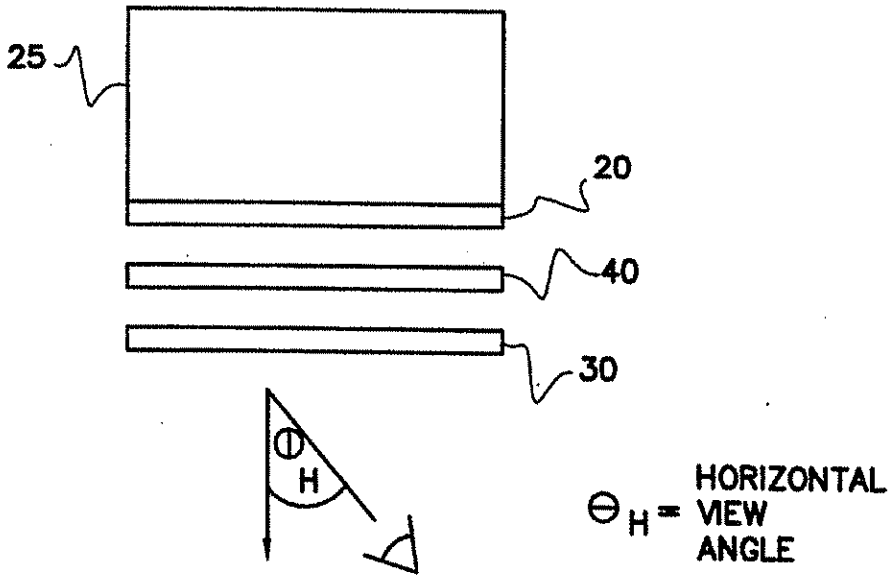
θV
θV = VERTICAL VIEW ANGLE

Fig. 4A


25
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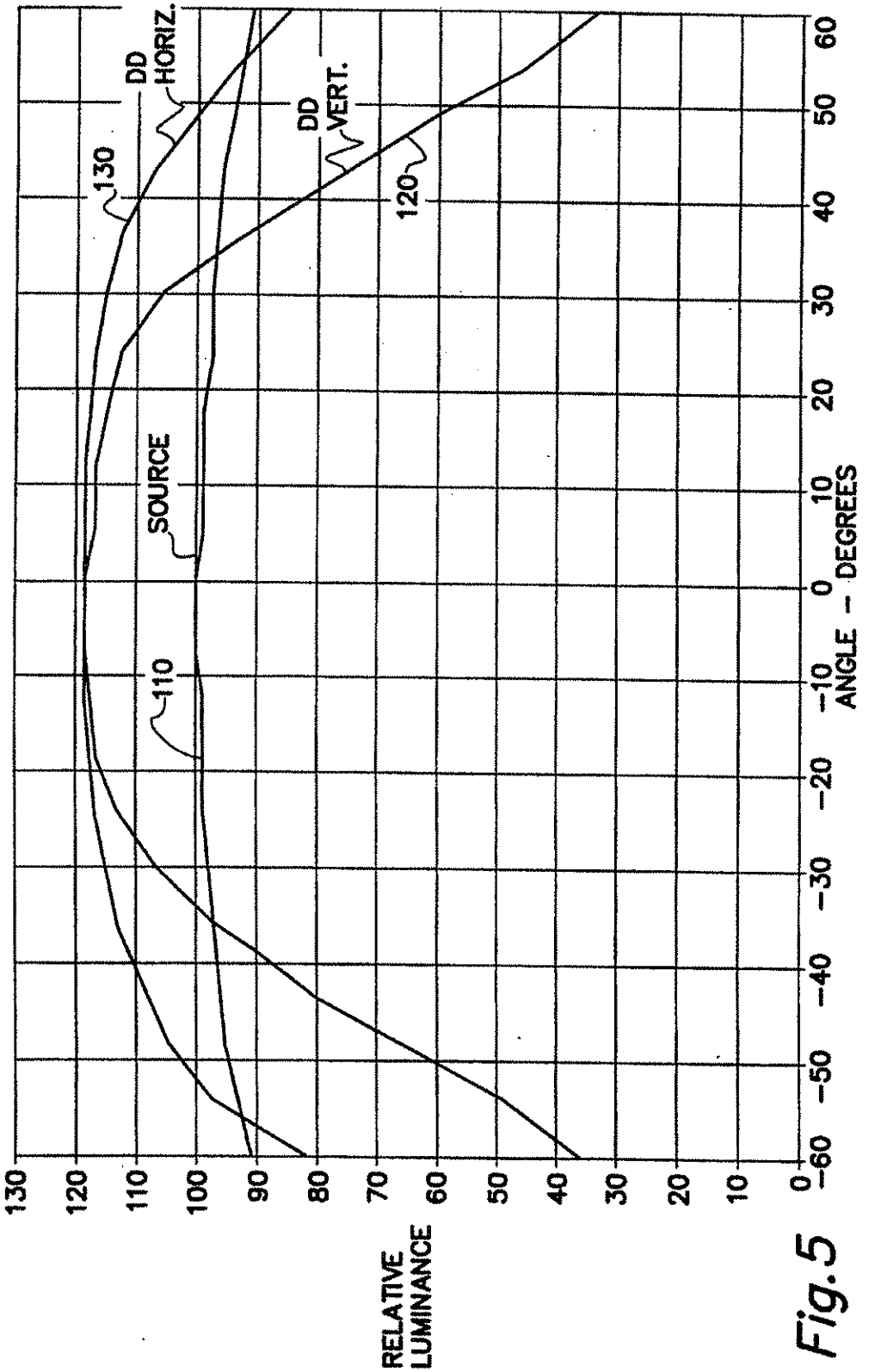
θH
θH = HORIZONTAL VIEW ANGLE

Fig. 4B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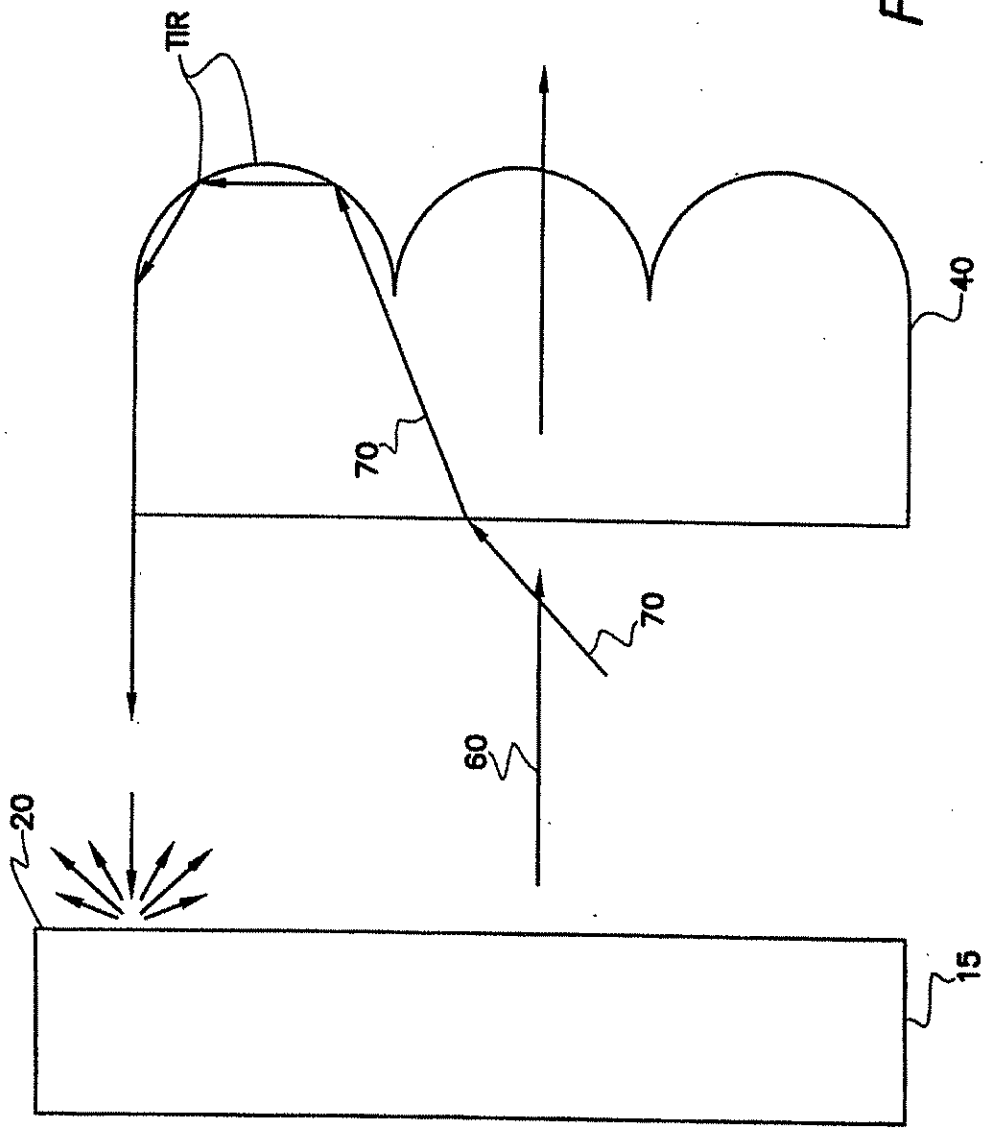
ANGLE − DEGREES

Fig. 5

Fig.6



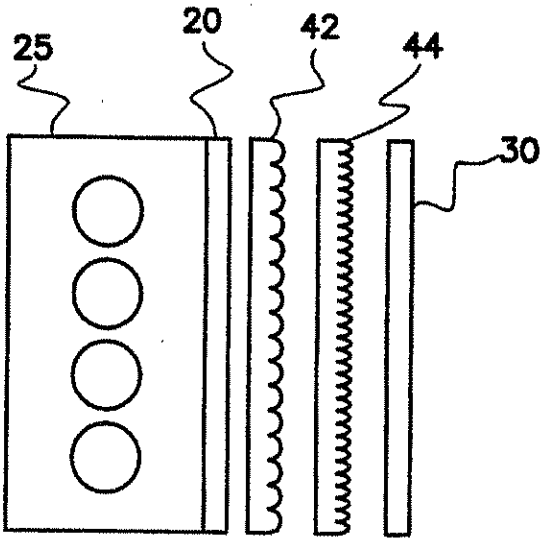


Fig. 7

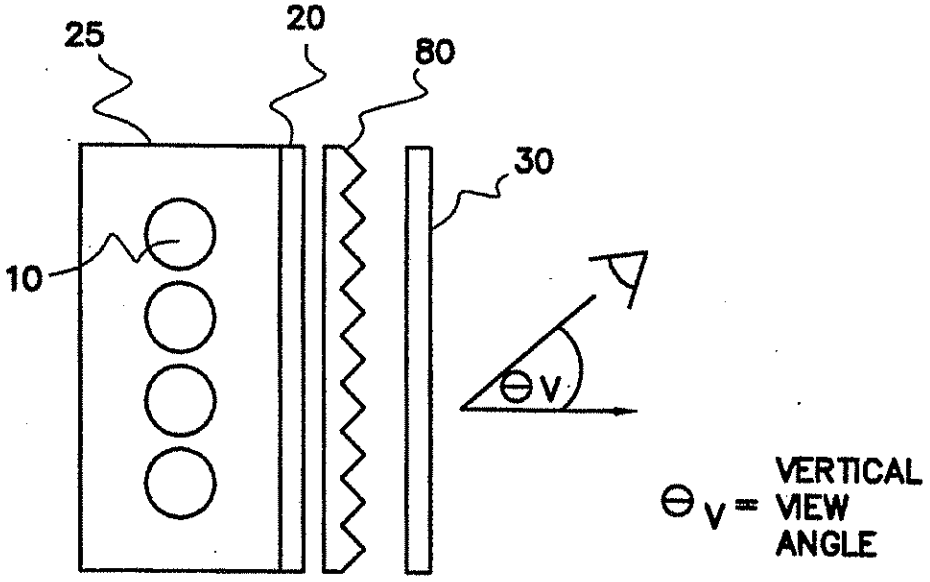


Fig. 10

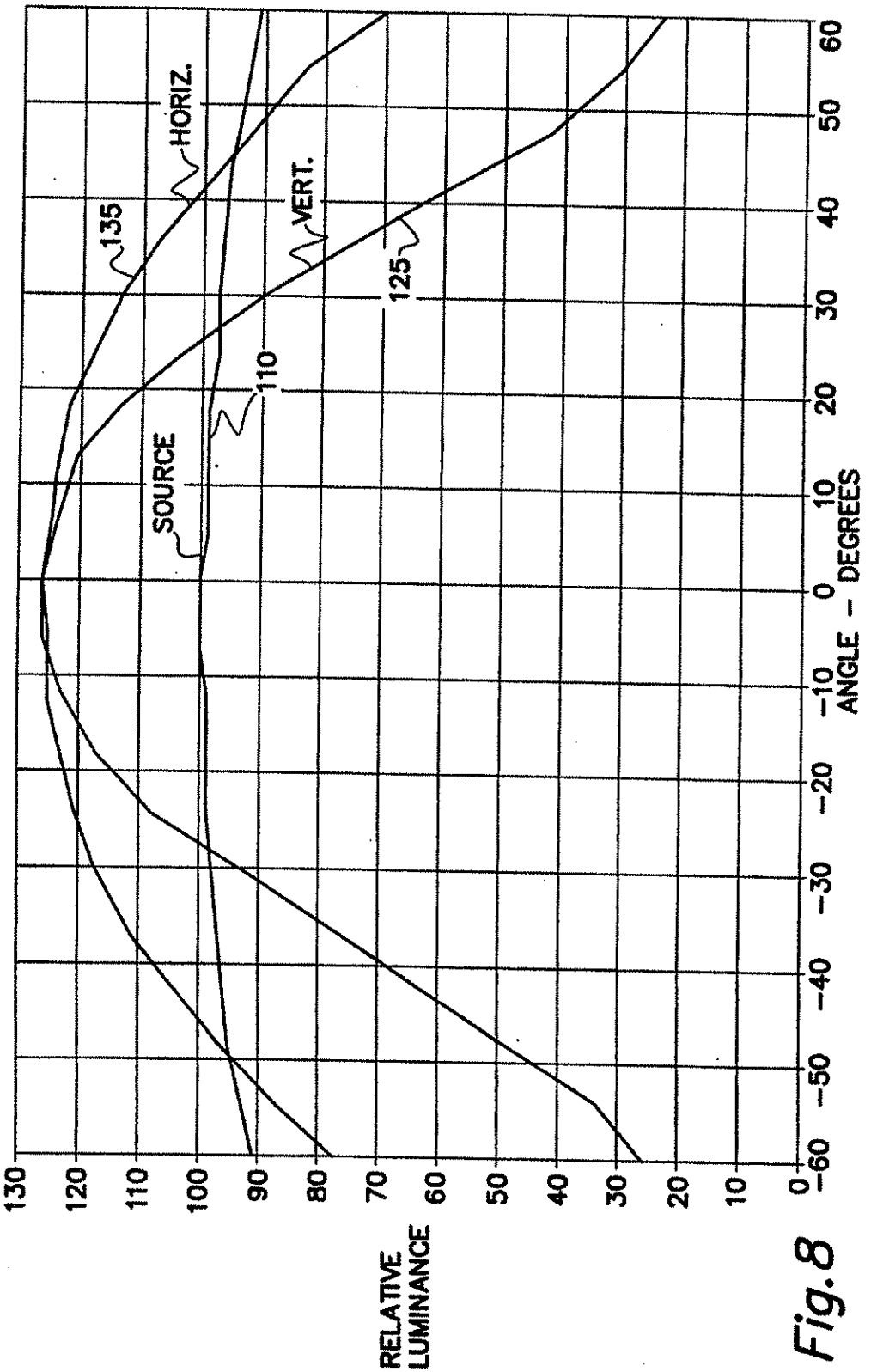

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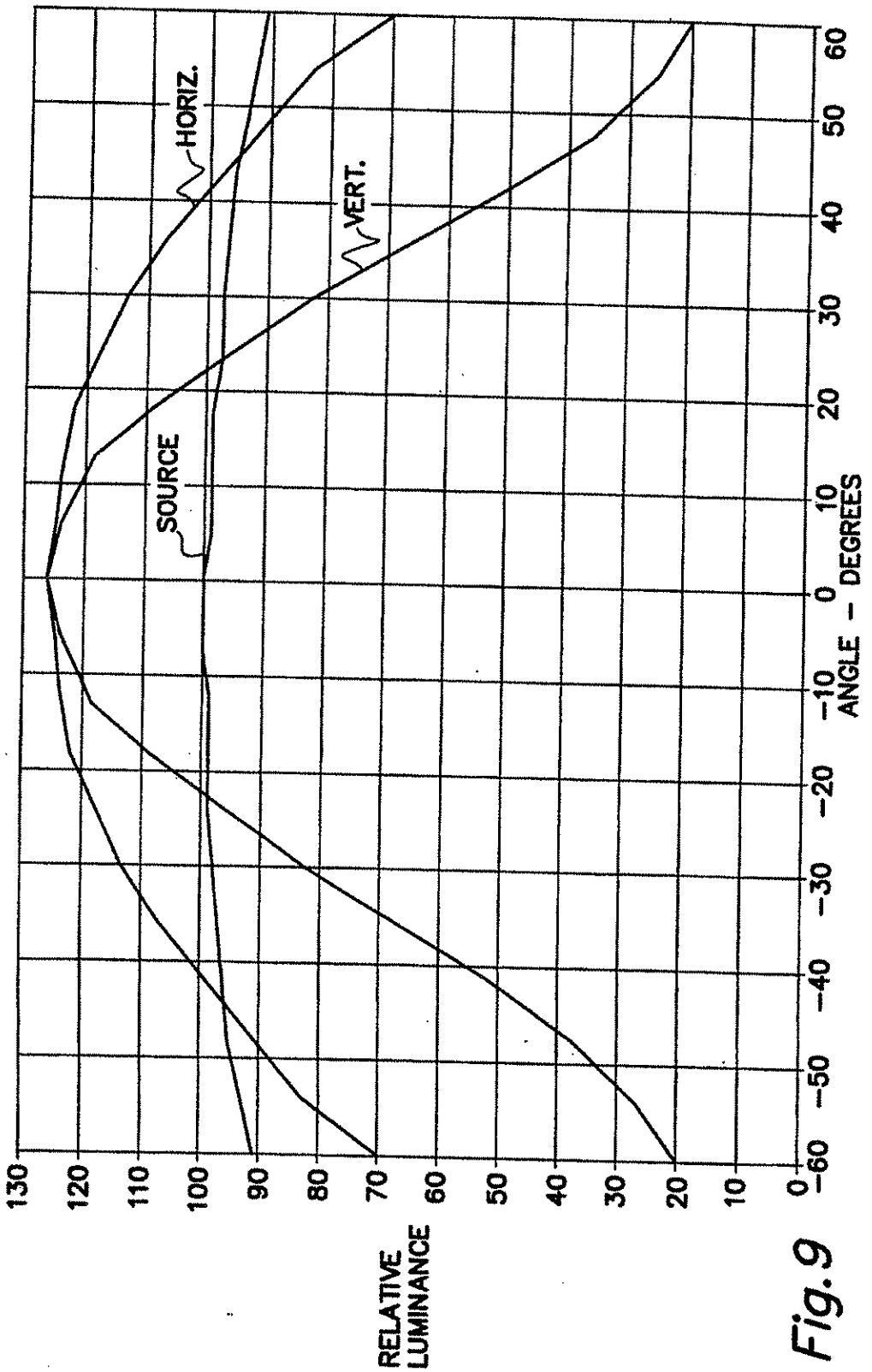
Fig. 8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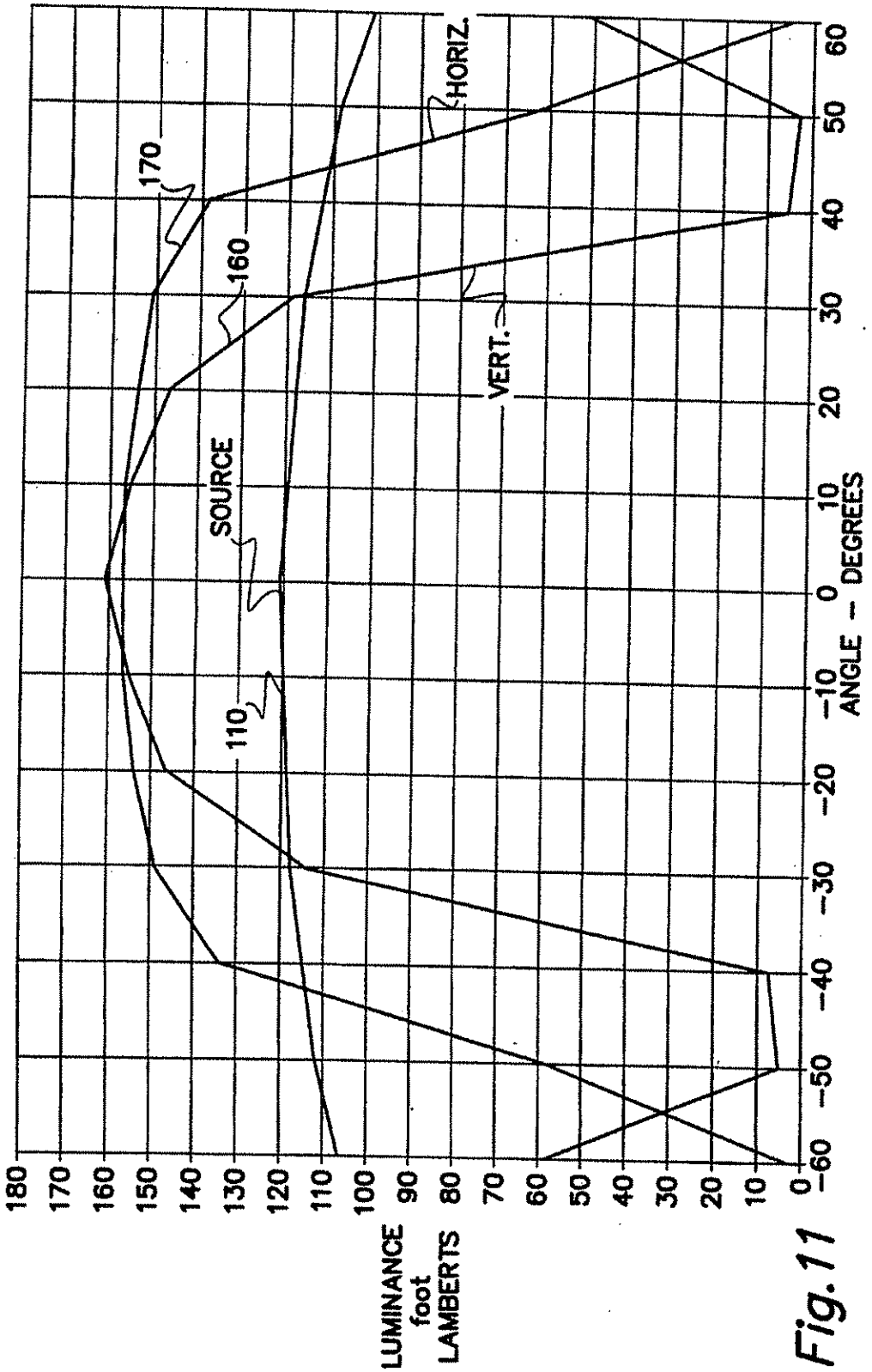
ANGLE − DEGREES

Fig. 9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ANGLE — DEGREES

Fig. 11

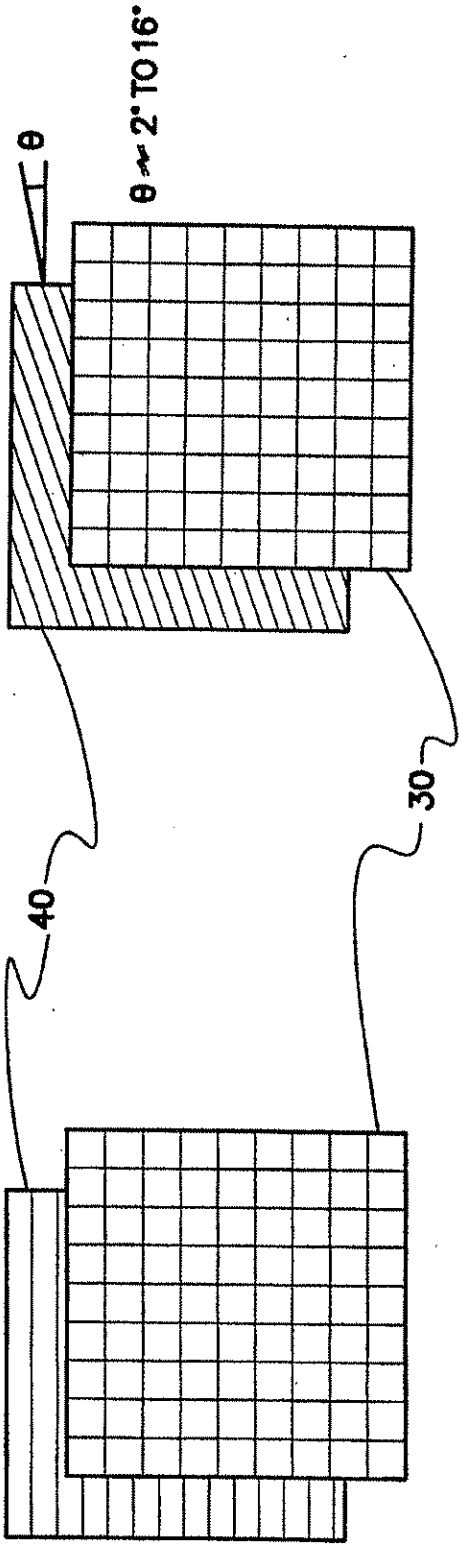

Fig. 12

DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

This invention relates in general to flat panel liquid crystal displays and, more particularly, to a liquid crystal display (LCD) having a directional diffuser to provide a tailored variation of luminance with viewing angle.

There are commercially available liquid crystal displays for use in various applications, including for example aircraft cockpit displays. However, a typical characteristic of the liquid crystal panel used therein is a wide variation of the light transmission of the liquid crystal panel with viewing angle, especially the vertical viewing angle. This results in gray-scale errors and off-state errors with viewing angle. That is to say, the brightness of certain areas of the display when viewed at angles above or below a vertical viewing angle normal to the display surface, may be substantially different than the brightness of those areas when viewed at an angle normal to the display surface. This variation of brightness or luminance with viewing angle is generally undesirable and particularly undesirable in those cases where the information being displayed on the liquid crystal display is critical to an operation such as controlling or navigating an aircraft.

In addition, a typical diffuser used to provide a light source for backlighting a typical liquid crystal display ordinarily provides a constant luminance with viewing angle and therefore provides the same amount of energy for any given viewing angle of the display. In certain applications, such as for example an aircraft cockpit, the typical vertical viewing angle is fixed within a relatively narrow range and it would therefore be desirable to concentrate a higher percentange of the energy from the light source within a particular range of viewing angles.

It would therefore be desirable to provide a directional diffuser for use with a liquid crystal display to provide a tailored variation of luminance with viewing angle while also providing a concentration of the light energy from the light source within a predetermined range of viewing angles.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a directional diffuser element for a liquid crystal display to provide a tailored variation of luminance with viewing angle.

It is a further object of the present invention to provide a liquid crystal display having less variation of intermediate gray-level luminance with viewing angle.

It is still further an object of the present invention to provide a liquid crystal display combining the above features to provide a higher concentration of light energy, and therefore increased luminance, within a particular range of viewing angles thereby providing a more efficient use of light energy available from a light source.

The foregoing and other objects are achieved in the present invention wherein there is provided a liquid crystal display apparatus comprising a light source, a liquid crystal planar array of pixels for creating an image by controlling the amount of light allowed to pass through each of the pixels, and one or more directional diffuser lens arrays disposed between the light source and the liquid crystal array for providing a tailored variation of luminance from the liquid crystal display as a function of vertical viewing angle.

BRIEF DESCRIPTION OF THE DRAWINGS

The above mentioned and other features and objects of the present invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of alternative embodiments of the invention taken in conjunction with the accompanying drawings wherein:

FIG. 1 is an exploded view of a typical prior art backlit liquid crystal display;

FIG. 2 is an exploded view of the liquid crystal display of the present invention, having a directional diffuser lens array;

FIG. 3 illustrates a typical prior art LCD gray-level response showing the variation of luminance with vertical viewing angle;

FIGS. 4A and 4B show cross sectional side and top views of a typical assembly including the lens array of the present invention;

FIG. 5 illustrates the variation of luminance with viewing angle- for a light source alone and a light source combined with a single lens array;

FIG. 6 illustrates the path of various light rays when striking the lens array at various angles;

FIG. 7 is a cross sectional view of a preferred embodiment of the present invention with two lens arrays;

FIG. 8 illustrates the variation of luminance with viewing angle for the dual lens array configuration;

FIG. 9 illustrates the variation of luminance with viewing angle for a triple lens array configuration;

FIG. 10 is a cross sectional view of a configuration utilizing a triangular shaped lens array;

FIG. 11 illustrates the variation of luminance with viewing angle for the triangular shaped lens array; and

FIG. 12 shows the angular rotation of the lens array with respect to the LCD matrix array to eliminate residual moire effects.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to FIG. 1 there is shown a cross section of a typical prior art liquid crystal display apparatus including backlight array 25 comprising lamp 10, rear reflecting surface 15 and lambertian diffuser 20. The backlight array provides a source of light which impinges on liquid crystal panel 30 comprised of a number of individual liquid crystal elements which are alternately energized in order to form a desired pattern or image for viewing from the front of the liquid crystal display.

While this typical prior art liquid crystal panel may be adequate for certain applications where the normal viewing angle is more or less at an angle normal to the display surface, this display is not optimum for applications wherein the typical viewing angle is other than at an angle normal to the display surface. This prior art display exhibits a relatively wide variation of light transmission with viewing angle, especially the vertical viewing angle. As illustrated in FIG. 3 this variation also changes with the level of lumination for various gray-levels or intermediate intensities for a given display.

As can be seen in the curves of FIG. 3, the luminance emitted from the lower gray-levels of the LCD system increases significantly with increasing vertical viewing angle. This variation presents an undesirably large luminance increase with angle when the information being presented is low-level luminance information, such as for avionics applications including weather radar or attitude director indicator presentations. As a pilot viewing the display moves his vertical perspective, or his viewing angle, higher above a normal angle to the display (larger vertical viewing angles), he observes a low luminance field increase significantly in luminance, thereby causing confusion in interpretation of critical display information.

In addition, the lambertian diffuser of the typical prior art display, element 20 of FIG. 1, provides for a nearly equal luminance in all angular viewing directions. In most applications a 180° field of view in both horizonal and vertical directions is not required. It would therefore be more energy efficient if a substantial portion of the light energy could be redirected so as to be concentrated in the viewing angles of interest for a particular application.

The apparatus of the present invention includes the backlight array and liquid crystal of the prior art as shown in FIG. 1 with the addition of a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30, as shown in FIG. 2. It was found that by inserting a directional diffuser consisting of a cylindrical lens array 40 between the lambertian diffuser and the liquid crystal panel that both of the desired effects could be accomplished. That is, the overall light energy is concentrated within a desired rang of viewing angles and the variation of luminance with viewing angle is tailored to offset that which is obtained through the liquid crystal display alone.

For example, FIG. 5 illustrates that with the insertion of lens array 40 as shown in FIGS. 4A and 4B, the overall luminance has increased approximately 20 percent within a range from −20° to +20° viewing angle and the desired decrease in luminance with increased vertical viewing angle is obtained between approximately +10° and +35° of vertical viewing angle. Curve 110 of FIG. 5 illustrates the variation of luminance with viewing angle for the lambertian light source only, in both the horizontal and vertical angles while curves 120 and 130 respectively represent a variation of luminance with vertical and horizontal viewing angles for the backlight including lens array 40.

The effect which results from the insertion of the cylindrical lens array is explained by reference to FIG. 6 wherein there are shown light rays from the lambertian (having uniform luminance with angle) source diffuser impinging on the lens array from various angles. An air gap must be present at the interface of the lambertian diffuser and the lens array. The normal 4 percent loss per surface due to fresnel reflections is not incurred, because the surface reflections are returned to the diffuser and reflected again.

Those rays that are normal to the source diffuser but less than the critical angle within the lens array are passed through the lens array materially unobstructed, except for a small amount of surface reflection. Rays which enter at oblique angles and are greater than the critical angle of the lens array undergo total internal reflection at the inside of the lens surface as illustrated by ray tracing 70. These rays are reflected with no loss due to the total internal reflection effect around the lens periphery. They exit the rear of the lens array and return to the source diffuser where they undergo a secondary diffuse reflection from the source diffuser.

However, because the source diffuser is not totally reflective, some of the returned rays are transmitted through the diffuser and are then reflected from the backlight enclosure surface 15 of FIG. 4A. Some fraction of these rays are reflected internally to exit the diffuser again. These reflected rays again have a lambertian distribution at the surface of lambertian diffuser 20. It is apparent from this interaction between the lens array and the backlight that rays which impinge close to the normal tend to be intensified while those rays which impinge at oblique angles undergo total internal reflection and are returned to the diffuser and diminished somewhat from this statistical process.

However, the roll off or variation with vertical viewing angle for this single directional diffuser cylindrical lens array was not sufficient to offset the effects of the liquid crystal display, and there were significant moire patterns caused by the interference between the lens array and the display panel wherein the lens array contained 142 lenses per inch and the display panel matrix had a spatial frequency resolution of 172 dots or pixels per inch.

For the desired specific implementation it was discovered that the adverse interaction producing moire patterns could be eliminated by including a second lens array with a different number of lenses per inch. The combination of the dual lenses increased the desired reduction in luminance with increased viewing angle, and in addition reduced or eliminated the moire patterns with the selection of an appropriate pitch, or number of lenses per inch, for the two lenses in question.

As illustrated in FIG. 7, one of the lens arrays 42 was selected to have a relatively coarse pitch with respect to that of the liquid crystal display and the second lens array 44 was selected to have a relatively fine pitch with respect to that of liquid crystal display. FIG. 8 illustrates again the relatively flat response of the lambertian source diffuser alone curve 110, and the increased roll off with vertical viewing angle of curve 125 as well as the corresponding variation of luminance with horizonal viewing angle as illustrated by curve 135 for the dual lens array of FIG. 8.

In general it was discovered that the addition of additional lens arrays caused a steeper or more rapid variation of the change in luminance with vertical viewing angle, which was desirable, but the corresponding change in luminance with variations in horizonal viewing angle also became steeper, which was not desirable for the particular application in question. For the particular application in question the preferred embodiment included two lens arrays in series which provided the best tradeoff of decrease in luminance with variation of vertical viewing angle, while not adversely affecting the variation in luminance with horizonal viewing angle.

In addition, since moire effects result when both of the lens arrays have the same spatial frequency, the rear array 42 should have a coarse resolution or low spatial frequency while the front lens array 44 should have a fine resolution or high spatial frequency. The lens arrays and the panel spatial frequencies should be selected to avoid integral multiples of the other. Thus the fine lens array should be as high a spatial frequency as is practical and should be a non integral multiple of the panel frequency. According to these guidelines the fine

array frequency becomes approximately 2.5 times the display spatial frequency and the coarse array frequency should be approximately the fine array frequency divided by 3.5, 4.5, 5.5 or as required for the most convenient fabrication.

It was also discovered that the maximum increase in luminance was obtained using a triangular lens array having an included angle of 90° as illustrated in FIG. 10. This configuration resulted in a variation of luminance with vertical and horizonal viewing angles which was quite steep as illustrated by curves 160 and 170 of FIG. 11. Other lens array shapes may be selected as desired to obtain the required concentration of luminance and variation of luminance with vertical and horizonal viewing angle for a particular application.

Even though the spatial frequencies of the directional diffuser lens array and LCD panel have been selected to be greatly different and non-integer multiples, some visual banding effects or moire pattern effects may still be apparent to the viewer. This is especially true at off-axis viewing conditions. This residual moire can be removed by rotating the lens array 40 with the respect to the LCD array 30, as illustrated in FIG. 12. This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual moire.

In addition to the angular redistribution of the light from the directional diffuser, the lens array also provides an additional diffusing effect, especially for any step variations in luminance that are parallel to (or nearly parallel to within a few degrees) the axis of the lens array. This allows the reduction of the thickness or optical density of the conventional diffuser while still achieving the same system luminance uniformity and masking of undesired spatial artifacts from the light source, but with higher luminance at the output.

While there have been described above the principals of invention in conjunction with several specific embodiments, it is to be clearly understood that these descriptions are made only by way of example and not as a limitation to the scope of the invention.

We claim:

1. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel, wherein said liquid crystal panel comprises a plurality of pixels arranged in rows and columns, and wherein the number of rows of pixels per unit height, or pitch, of the liquid crystal panel is a first value; the number of lenslets per unit height, or pitch, of said first lens array is a second value which is less than said first value; and the number of lenslets per unit height, or pitch, of said second lens array is a third value which is greater than said first value.

2. A display apparatus in accordance with claim 1 wherein said third value is a non-integral multiple of said first value and is also a non-integral multiple of said second value.

3. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel, wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel.

* * * * *

2.

PATENT APPLICATION FOR A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY

BACKGROUND OF THE INVENTION

This invention relates in general to flat panel liquid crystal displays and, more particularly, to a liquid crystal display (LCD) having a directional diffuser to provide a tailored variation of luminance with viewing angle.

There are commercially available liquid crystal displays for use in various applications, including for example aircraft cockpit displays. However, a typical characteristic of the liquid crystal panel used therein is a wide variation of the light transmission of the liquid crystal panel with viewing angle, especially the vertical viewing angle. This results in gray-scale errors and off-state errors with viewing angle. That is to say, the brightness of certain areas of the display when viewed at angles above or below a vertical viewing angle normal to the display surface, may be substantially different than the brightness of those areas when viewed at an angle normal to the display surface. This variation of brightness or luminance with viewing angle is generally undesirable and particularly undesirable in those cases where the information being displayed on the liquid crystal display is critical to an operation such as controlling or navigating an aircraft.

In addition, a typical diffuser used to provide a light source for backlighting a typical liquid crystal display ordinarily provides a constant luminance with viewing angle and therefore provides the same amount of energy for any given viewing angle of the display. In certain applications, such as for example an aircraft cockpit, the typical vertical viewing angle is fixed within a relatively narrow range and it would therefore be desirable to concentrate a higher percentange of the energy from the light source within a particular range of viewing angles.

It would therefore be desirable to provide a directional diffuser for use with a liquid crystal display to provide a tailored variation of luminance with viewing angle while also providing a concentration of the light energy from the light source within a predetermined range of viewing angles.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a directional diffuser element for a liquid crystal display to provide a tailored variation of luminance with viewing angle.

It is a further object of the present invention to provide a liquid crystal display having less variation of intermediate gray-level luminance with viewing angle.

It is still further an object of the present invention to provide a liquid crystal display combining the above features to provide a higher concentration of light energy, and therefore increased luminance, within a particular range of viewing angles thereby providing a more efficient use of light energy available from a light source.

The foregoing and other objects are achieved in the present invention wherein there is provided a liquid crystal display apparatus comprising a light source, a liquid crystal planar array of pixels for creating an image by controlling the amount of light allowed to pass through each of the pixels, and one or more directional diffuser lens arrays disposed between the light source and the liquid crystal array for providing a tailored variation of luminance from the liquid crystal display as a function of vertical viewing angle.

BRIEF DESCRIPTION OF THE DRAWINGS

The above mentioned and other features and objects of the present invention and the manner of attaining them will become more apparent and the invention itself will be best understood by reference to the following description of alternative embodiments of the invention taken in conjunction with the accompanying drawings wherein:

Figure 1 is an exploded view of a typical prior art backlit liquid crystal display;

Figure 2 is an exploded view of the liquid crystal display of the present invention, having a directional diffuser lens array;

Figure 3 illustrates a typical prior art LCD gray-level response showing the variation of luminance with vertical viewing angle;

Figures 4A and 4B show cross sectional side and top views of a typical assembly including the lens array of the present invention;

Figure 5 illustrates the variation of luminance with viewing angle for a light source alone and a light source combined with a single lens array;

Figure 6 illustrates the path of various light rays when striking the lens array at various angles;

Figure 7 is a cross sectional view of a preferred embodiment of the present invention with two lens arrays;

Figure 8 illustrates the variation of luminance with viewing angle for the dual lens array configuration;

Figure 9 illustrates the variation of luminance with viewing angle for a triple lens array configuration;

Figure 10 is a cross sectional view of a configuration utilizing a triangular shaped lens array;

Figure 11 illustrates the variation of luminance with viewing angle for the triangular shaped lens array; and

Figure 12 shows the angular rotation of the lens array with respect to the LCD matrix array to eliminate residual moire effects.

DESCRIPTION OF A PREFERRED EMBODIMENT

Referring now to Figure 1 there is shown a cross section of a typical prior art liquid crystal display apparatus including backlight array 25 comprising lamp 10, rear reflecting surface 15 and lambertian diffuser 20. The backlight array provides a source of light which impinges on liquid crystal panel 30 comprised of a number of individual liquid crystal elements which are alternately energized in order to form a desired pattern or image for viewing from the front of the liquid crystal display.

While this typical prior art liquid crystal panel may be adequate for certain applications where the normal viewing angle is more or less at an angle normal to the display surface, this display is not optimum for applications wherein the typical viewing angle is other than at an angle normal to the display surface. This prior art display exhibits a relatively wide variation of light transmission with viewing angle, especially the vertical viewing angle. As illustrated in Figure 3, this variation also changes with the level of lumination for various gray-levels or intermediate intensities for a given display.

As can be seen in the curves of Figure 3, the luminance emitted from the lower gray-levels of the LCD system increases significantly with increasing vertical viewing angle. This variation presents an undesirably large luminance increase

with angle when the information being presented is low-level luminance information, such as for avionics applications including weather radar or attitude director indicator presentations. As a pilot viewing the display moves his vertical perspective, or his viewing angle, higher above a normal angle to the display (larger vertical viewing angles), he observes a low luminance field increase significantly in luminance, thereby causing confusion in interpretation of critical display information.

In addition, the lambertian diffuser of the typical prior art display, element 20 of Figure 1, provides for a nearly equal luminance in all angular viewing directions. In most applications a 180° field of view in both horizonal and vertical directions is not required. It would therefore be more energy efficient if a substantial portion of the light energy could be redirected so as to be concentrated in the viewing angles of interest for a particular application.

The apparatus of the present invention includes the backlight array and liquid crystal of the prior art as shown in Figure 1 with the addition of a lens array 40 inserted between the lambertian diffuser 20 of the prior art and liquid crystal display panel 30, as shown in Figure 2. It was found that by inserting a directional diffuser consisting of a cylindrical lens array 40 between the lambertian diffuser and the liquid crystal panel that both of the desired effects could be accomplished. That is, the overall light energy is

concentrated within a desired range of viewing angles and the variation of luminance with viewing angle is tailored to offset that which is obtained through the liquid crystal display alone.

For example, Figure 5 illustrates that with the insertion of lens array 40 as shown in Figures 4A and 4B, the overall luminance has increased approximately 20 percent within a range from -20° to + 20° viewing angle and the desired decrease in luminance with increased vertical viewing angle is obtained between approximately +10° and +35° of vertical viewing angle. Curve 110 of Figure 5 illustrates the variation of luminance with viewing angle for the lambertian light source only, in both the horizontal and vertical angles while curves 120 and 130 respectively represent a variation of luminance with vertical and horizontal viewing angles for the backlight including lens array 40.

The effect which results from the insertion of the cylindrical lens array is explained by reference to Figure 6 wherein there are shown light rays from the lambertian (having uniform luminance with angle) source diffuser impinging on the lens array from various angles. An air gap must be present at the interface of the lambertian diffuser and the lens array. The normal 4 percent loss per surface due to fresnel reflections is not incurred, because the surface reflections are returned to the diffuser and reflected again.

Those rays that are normal to the source diffuser but

less than the critical angle within the lens array are passed through the lens array materially unobstructed, except for a small amount of surface reflection. Rays which enter at oblique angles and are greater than the critical angle of the lens array undergo total internal reflection at the inside of the lens surface as illustrated by ray tracing 70. These rays are reflected with no loss due to the total internal reflection effect around the lens periphery. They exit the rear of the lens array and return to the source diffuser where they undergo a secondary diffuse reflection from the source diffuser.

However, because the source diffuser is not totally reflective, some of the returned rays are transmitted through the diffuser and are then reflected from the backlight enclosure surface 15 of Figure 4A. Some fraction of these rays are reflected internally to exit the diffuser again. These reflected rays again have a lambertian distribution at the surface of lambertian diffuser 20. It is apparent from this interaction between the lens array and the backlight that rays which impinge close to the normal tend to be intensified while those rays which impinge at oblique angles undergo total internal reflection and are returned to the diffuser and diminished somewhat from this statistical process.

However, the roll off or variation with vertical viewing angle for this single directional diffuser cylindrical lens array was not sufficient to offset the effects of the

liquid crystal display, and there were significant moire patterns caused by the interference between the lens array and the display panel wherein the lens array contained 142 lenses per inch and the display panel matrix had a spatial frequency resolution of 172 dots or pixels per inch.

For the desired specific implementation it was discovered that the adverse interaction producing moire patterns could be eliminated by including a second lens array with a different number of lenses per inch. The combination of the dual lenses increased the desired reduction in luminance with increased viewing angle, and in addition reduced or eliminated the moire patterns with the selection of an appropriate pitch, or number of lenses per inch, for the two lenses in question.

As illustrated in Figure 7, one of the lens arrays 42 was selected to have a relatively coarse pitch with respect to that of the liquid crystal display and the second lens array 44 was selected to have a relatively fine pitch with respect to that of liquid crystal display. Figure 8 illustrates again the relatively flat response of the lambertian source diffuser alone curve 110, and the increased roll off with vertical viewing angle of curve 125 as well as the corresponding variation of luminance with horizonal viewing angle as illustrated by curve 135 for the dual lens array of Figure 8.

In general it was discovered that the addition of additional lens arrays caused a steeper or more rapid varia-

tion of the change in luminance with vertical viewing angle, which was desirable, but the corresponding change in luminance with variations in horizonal viewing angle also became steeper, which was not desirable for the particular application in question. For the particular application in question the preferred embodiment included two lens arrays in series which provided the best tradeoff of decrease in luminance with variation of vertical viewing angle, while not adversely affecting the variation in luminance with horizonal viewing angle.

In addition, since moire effects result when both of the lens arrays have the same spatial frequency, the rear array 42 should have a coarse resolution or low spatial frequency while the front lens array 44 should have a fine resolution or high spatial frequency. The lens arrays and the panel spatial frequencies should be selected to avoid integral multiples of the other. Thus the fine lens array should be as high a spatial frequency as is practical and should be a non-integral multiple of the panel frequency. According to these guidelines the fine array frequency becomes approximately 2.5 times the display spatial frequency and the coarse array frequency should be approximately the fine array frequency divided by 3.5, 4.5, 5.5 or as required for the most convenient fabrication.

It was also discovered that the maximum increase in luminance was obtained using a triangular lens array having an

included angle of 90° as illustrated in Figure 10. This configuration resulted in a variation of luminance with vertical and horizonal viewing angles which was quite steep as illustrated by curves 160 and 170 of Figure 11. Other lens array shapes may be selected as desired to obtain the required concentration of luminance and variation of luminance with vertical and horizonal viewing angle for a particular application.

Even though the spatial frequencies of the directional diffuser lens array and LCD panel have been selected to be greatly different and non-integer multiples, some visual banding effects or moire pattern effects may still be apparent to the viewer. This is especially true at off-axis viewing conditions. This residual moire can be removed by rotating the lens array 40 with the respect to the LCD array 30, as illustrated in Figure 12. This rotation of the lens array by a few degrees (Typically 2 to 16 degrees) from the horizontal axis causes a small change in the effective spatial frequency difference of the two arrays and thereby eliminates the residual moire.

In addition to the angular redistribution of the light from the directional diffuser, the lens array also provides an additional diffusing effect, especially for any step variations in luminance that are parallel to (or nearly parallel to within a few degrees) the axis of the lens array. This allows the reduction of the thickness or optical density of the

conventional diffuser while still achieving the same system luminance uniformity and masking of undesired spatial artifacts from the light source, but with higher luminance at the output.

While there have been described above the principals of invention in conjunction with several specific embodiments, it is to be clearly understood that these descriptions are made only by way of example and not as a limitation to the scope of the invention.

CLAIMS

Claim 1. A display apparatus comprising:

a light source;

a substantially planar array mounted adjacent to said light source for receiving light from said light source, said array comprising a plurality of controllable apertures for creating an image by controlling the amount of light from said light source which is allowed to pass through each of said apertures; and

luminance control means disposed between said light source and said planar array for providing a predetermined variation with viewing angle of light transmission from said light source through said luminance control means and said planar array.

Claim 2. A display apparatus in accordance with Claim 1 wherein said planar array comprises a liquid crystal panel having a characteristic variation of light transmission with viewing angle.

Claim 3. A display apparatus in accordance with Claim 2 wherein said luminance control means comprises a first lens array having a plurality of individual lenslets.

Claim 4. A display apparatus in accordance with ~~Claim 3~~ Claim 10 wherein each of said lenslets has a semi-cylindrical shape.

Claim 5. A display apparatus in accordance with ~~Claim 3~~ Claim 10 wherein each of said lenslets has a triangular cross section.

Claim 6. A display apparatus in accordance with Claim 3 wherein said luminance control means further comprises a second lens array disposed between said first lens array and said liquid crystal panel.

Claim 7. A display apparatus in accordance with ~~Claim 6~~ Claim 10 wherein said liquid crystal panel comprises a plurality of pixels arranged in rows and columns, and wherein the number of rows of pixels per unit height, or pitch, of the liquid crystal panel is a first value; the number of lenslets per unit height, or pitch, of said first lens array is a second value which is less than said first value; and the number of lenslets per unit height, or pitch, of said second lens array is a third value which is greater than said first value.

Claim 8. A display apparatus in accordance with claim 7 wherein said third value is a non-integral multiple of said first value and is also a non-integral multiple of said second value.

Claim 9. A display apparatus in accordance with Claim 3 wherein said first lens array is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenlets and said liquid crystal panel.

07/911,517

ABSTRACT OF THE DISCLOSURE

A display apparatus including a light source, a liquid crystal panel, and one or more directional diffuser lens arrays disposed therebetween provides a tailored variation of luminance with viewing angle, a uniform variation of luminance with viewing angle within a first predetermined range of viewing angles and a concentration of light energy within a second predetermined range of viewing angles.

3.

AMENDMENT DATED FEBRUARY 2, 1993

G02504
#4

"PATENT"

Applicant: R. McCartney et al) Art Unit: 2504
Serial No.: 07/911,547) Examiner: H. Mai
Filed: 9 July 1992) Docket No.: A6213491

For: "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

AMENDMENT

Honorable Commissioner of
Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

In response to the Office Action mailed on 2 October 1992, please amend the above-identified application as follows:

IN THE CLAIMS

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Kindly delete claims 1, 2 and 3.

Kindly amend claims 4, 5, 7 and 9 as follows:

In claims 4 and 5, at line 1, delete "Claim 3", and substitute therefor - - Claim 10 - -.

In claim 7, at line 1, delete "Claim 6", and substitute therefor - - Claim 10 - -.

Claim 9. (Amended) A display apparatus in accordance with Claim [3] 10 wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel.

Kindly add new claim 10 as follows:

Claim 10. A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel.

REMARKS

The applicants wish to thank the Examiner for his citation to the noted references and his accompanying remarks. While the cited references are certainly pertinent to the claimed invention, applicants respectfully disagree with the interpretation of the cited references by the Examiner and his conclusions drawn therefrom.

The Examiner has rejected claims 1-5 under 35 USC 102 (a or b) as being clearly anticipated by Abileah et al or the cited IBM article. While not necessarily providing the same function, the structure of these references does appear to be similar to that of applicants' invention. In order to further prosecution of the application, claims 1-3 have been deleted

and claims 4 and 5 amended to depend from new claim 10.

In addition, the Examiner has rejected claims 1-3 and 6-9 under 35 USC 103 as being unpatentable over Abileah et al or the IBM article in view of Hamada. Applicants have added new claim 10 which essentially includes the limitations of claims 1-3 and 6, resulting in a new claim for an apparatus having two lens arrays.

The Examiner contends that it would have been obvious, in view of Hamada, to add a second lens array to the structure of Abileah or IBM. In order to support a combination of references under 35 USC 103 there must be some suggestion for the combination. As the Hamada reference is concerned with a projection apparatus, there would be no suggestion to use the dual lens arrays of Hamada in the direct view apparatus of Abileah or IBM. Particularly since the dual lens array of Hamada is used to overcome a problem specifically associated with projection displays.

The two lens arrays of Hamada are used in a projection device to reduce the dimming at the outer edges. As such the dual lens arrays would not be suggested to the direct view display of Abileah or IBM.

In addition, at no point in any of the references is there any discussion of eliminating moire effects with appropriate selection of the relative pitch of the two lens arrays as specifically described and claimed by the applicants. Also, there is no discussion of rotating one of the

lens arrays with respect to the liquid crystal panel as specifically claimed in applicants' claim 9.

Based on the foregoing, applicants contend that claims 4, 5, 7, 9 and 10, as amended, are in condition for allowance and respecfully request same at the earliest opportunity.

Respectfully submitted,

Dale E. Jepsen
Attorney for Applicants
Reg. No. 31, 379

602/436-1336

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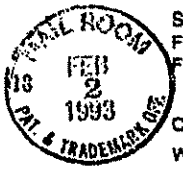
PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE



In re application of: R. McCARTNEY ET AL
Serial No.: 07/911,547 Group No.: 2504
Filed: 9 JULY 1992 Examiner: H. MAI
For: "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

Commissioner of Patents and Trademarks
Washington, D.C. 20231

AMENDMENT TRANSMITTAL

1. Transmitted herewith is an amendment for this application

STATUS

2. Applicant is
   - ☐ a small entity — verified statement:
     - ☐ attached.
     - ☐ already filed.
   - ☒ other than a small entity.

"EXPRESS MAIL" Date of Deposit 2 FEBRUARY 1993
Mailing Label No. EB279304420US
I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231
DALE E. JEPSEN
(Typed or printed name of person mailing paper or fee)
(Signature of person mailing paper or fee)

4.

USPTO OFFICE ACTION
DATED MAY 6, 1993

UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

SERIAL NUMBER	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
07/911,547	07/09/92	MC CARTNEY R	A6213491

MATH EXAMINER

B5N2

DALE E. JEPSEN
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ART UNIT	PAPER NUMBER
2504	5

DATE MAILED: 05/06/93

This is a communication from the examiner in charge of your application
COMMISSIONER OF PATENTS AND TRADEMARKS

☐ This application has been examined ☑ Responsive to communication filed on 2/2/93 ☑ This action is made final.

A shortened statutory period for response to this action is set to expire 3 month(s), 0 days from the date of this letter.
Failure to respond within the period for response will cause the application to become abandoned. 35 U.S.C. 133

Part I THE FOLLOWING ATTACHMENT(S) ARE PART OF THIS ACTION:

1. ☑ Notice of References Cited by Examiner, PTO-892.
2. ☐ Notice re Patent Drawing, PTO-948.
3. ☐ Notice of Art Cited by Applicant, PTO-1449.
4. ☐ Notice of Informal Patent Application, Form PTO-152.
5. ☐ Information on How to Effect Drawing Changes, PTO-1474.
6. ☐ _____

Part II SUMMARY OF ACTION

1. ☑ Claims 1-10 are pending in the application
   Of the above, claims _____ are withdrawn from consideration.
2. ☑ Claims 1-3 have been cancelled.
3. ☐ Claims _____ are allowed.
4. ☑ Claims 4-6 & 10 are rejected.
5. ☑ Claims 7-9 are objected to.
6. ☐ Claims _____ are subject to restriction or election requirement.
7. ☑ This application has been filed with informal drawings under 37 C.F.R. 1.85 which are acceptable for examination purposes.
8. ☐ Formal drawings are required in response to this Office action.
9. ☐ The corrected or substitute drawings have been received on _____. Under 37 C.F.R. 1.84 these drawings are ☐ acceptable. ☐ not acceptable (see explanation or Notice re Patent Drawing, PTO-948).
10. ☐ The proposed additional or substitute sheet(s) of drawings, filed on _____ has (have) been ☐ approved by the examiner. ☐ disapproved by the examiner (see explanation).
11. ☐ The proposed drawing correction, filed on _____, has been ☐ approved. ☐ disapproved (see explanation).
12. ☐ Acknowledgment is made of the claim for priority under U.S.C. 119. The certified copy has ☐ been received ☐ not been received ☐ been filed in parent application, serial no. _____; filed on _____.
13. ☐ Since this application appears to be in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under Ex parte Quayle, 1935 C.D. 11; 453 O.G. 213.
14. ☐ Other

EXAMINER'S ACTION

Applicant's arguments with respect to claims 4-10 have been considered but are deemed to be moot in view of the new grounds of rejection.

Claim 6 is rejected under 35 U.S.C. § 112, fourth paragraph, as being of improper dependent form for failing to further limit the subject matter of a previous claim.

Claim 6 depends from claim 3 which has been canceled. Therefore, claim 6 is not treated on the merits.

The following is a quotation of the appropriate paragraphs of 35 U.S.C. § 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
> (e) the invention was described in a patent granted on an application for patent by another filed in the United States before the invention thereof by the applicant for patent, or on an international application by another who has fulfilled the requirements of paragraphs (1), (2), and (4) of section 371(c) of this title before the invention thereof by the applicant for patent.

Claims 5 and 10 are rejected under 35 U.S.C. § 102(e) as being clearly anticipated by Abileah et al ('041) or Yoshida et al.

The recited limitations of claims 5 and 10 are shown in Abileah et al's Figs. 6, 8, column 13, line 18 through column 14, line 44 or Yoshida et al's Figs. 3, 5.

The following is a quotation of 35 U.S.C. § 103 which forms the basis for all obviousness rejections set forth in this Office action:

> A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject

> matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.
>
> Subject matter developed by another person, which qualifies as prior art only under subsection (f) or (g) of section 102 of this title, shall not preclude patentability under this section where the subject matter and the claimed invention were, at the time the invention was made, owned by the same person or subject to an obligation of assignment to the same person.

Claim 4 is rejected under 35 U.S.C. § 103 as being unpatentable over Abileah et al ('041) in view of Abileah et al ('783).

The '041 patent discloses in Figs. 6, 8 a display apparatus having first and second lens arrays with lenslets having a triangular cross section. The '041 patent lacks a teaching the lenslets having a semi-cylindrical shape.

The '783 patent teaches in Fig. 3 a lens array having lenslets disposed between a liquid crystal panel and a light source wherein the lenslets have semi-cylindrical shape for improving the brightness of the display device. Therefore, it would have been obvious at the time the invention was made to a person skilled in this art to modify the '041 patent by substituting the lens arrays with lenslets having semi-cylindrical shape for the lens arrays with triangular-cross-section lenslets for improving the brightness of the display as taught by the '783 patent.

Claims 7 and 9 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 8 is objected to as being dependent upon an objected claim which has allowable subject matter.

Applicant's amendment necessitated the new grounds of rejection. Accordingly, THIS ACTION IS MADE FINAL. See M.P.E.P. § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 C.F.R. § 1.136(a).

A SHORTENED STATUTORY PERIOD FOR RESPONSE TO THIS FINAL ACTION IS SET TO EXPIRE THREE MONTHS FROM THE DATE OF THIS ACTION. IN THE EVENT A FIRST RESPONSE IS FILED WITHIN TWO MONTHS OF THE MAILING DATE OF THIS FINAL ACTION AND THE ADVISORY ACTION IS NOT MAILED UNTIL AFTER THE END OF THE THREE-MONTH SHORTENED STATUTORY PERIOD, THEN THE SHORTENED STATUTORY PERIOD WILL EXPIRE ON THE DATE THE ADVISORY ACTION IS MAILED, AND ANY EXTENSION FEE PURSUANT TO 37 C.F.R. § 1.136(a) WILL BE CALCULATED FROM THE MAILING DATE OF THE ADVISORY ACTION. IN NO EVENT WILL THE STATUTORY PERIOD FOR RESPONSE EXPIRE LATER THAN SIX MONTHS FROM THE DATE OF THIS FINAL ACTION.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Huy K. Mai whose telephone number is (703) 308-4874.

Any inquiry of a general nature or relating to the status of this application should be directed to the Group receptionist whose telephone number is (703) 308-0956.

69

Mai/ks
April 26, 1993

William L. Sikes
WILLIAM L. SIKES
SUPERVISORY PATENT EXAMINER
GROUP 2500

5.

U.S. PATENT NO. 5,161,041

US005161041A

United States Patent [19]

Abileah et al.

[11] Patent Number: 5,161,041

[45] Date of Patent: Nov. 3, 1992

[54] **LIGHTING ASSEMBLY FOR A BACKLIT ELECTRONIC DISPLAY INCLUDING AN INTEGRAL IMAGE SPLITTING AND COLLIMATING MEANS**

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[73] Assignee: **OIS Optical Imaging Systems, Inc.**, Troy, Mich.

[21] Appl. No.: **514,737**

[22] Filed: **Apr. 26, 1990**

[51] **Int. Cl.**[5] **G02F 1/1335**

[52] **U.S. Cl.** **359/40**; 359/49

[58] **Field of Search** 350/334, 345; 359/40, 359/49

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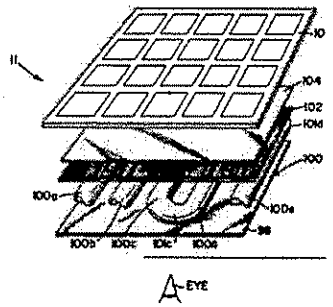
Primary Examiner—Stanley D. Miller
Assistant Examiner—Anita Pellman Gross
Attorney, Agent, or Firm—Myers, Liniak & Berenato

[57] **ABSTRACT**

An improved lighting assembly for a backlit electronic display includes an integrally formed image splitting-/collimating lens for effectively enlarging the area illuminated by any one or part of one of the lamps of the source of backlighting. Through the use of the improved optical assembly described herein, there is provided a backlit electronic display characterized by fewer lamps, reduced heating, and vastly improved intensity of illumination per unit area in a lower profile package.

22 Claims, 4 Drawing Sheets



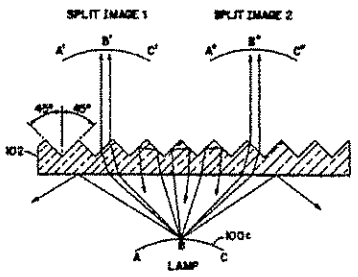


Fig.1

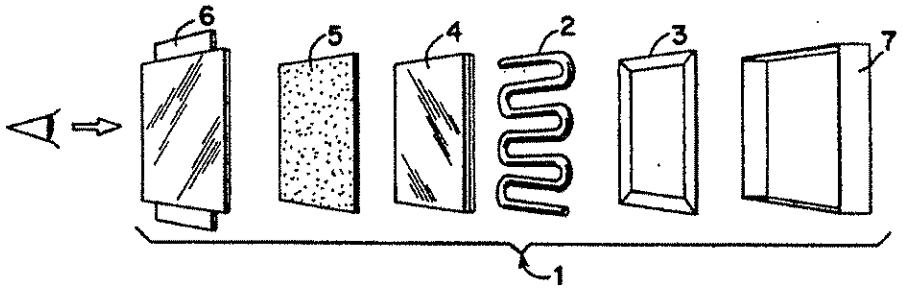


Fig.2A

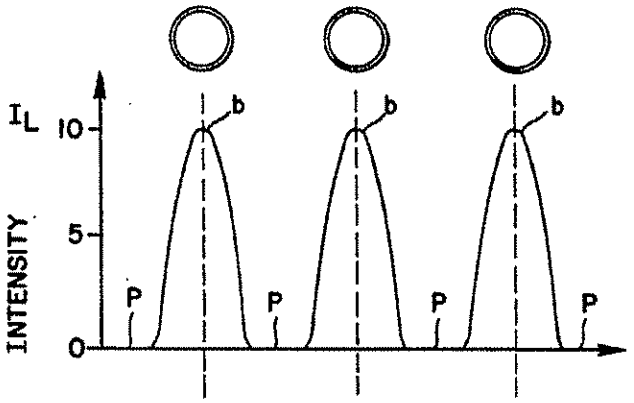


Fig.2B

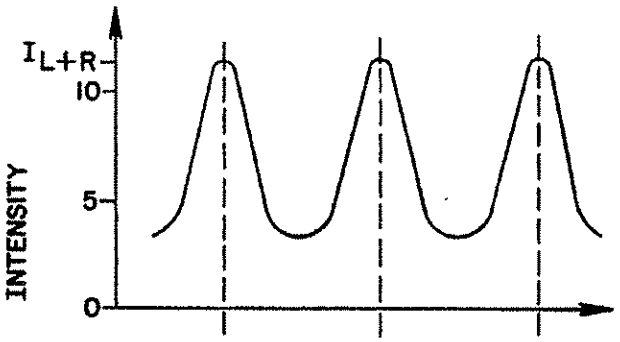


Fig.2C

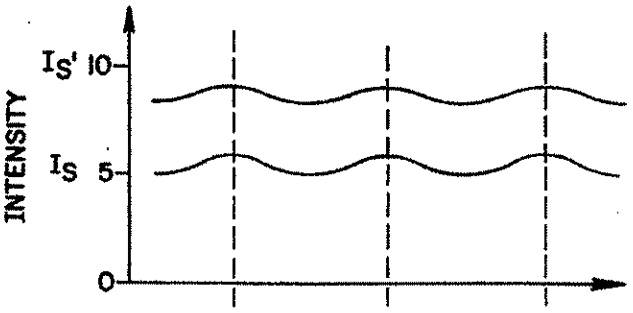


Fig.3

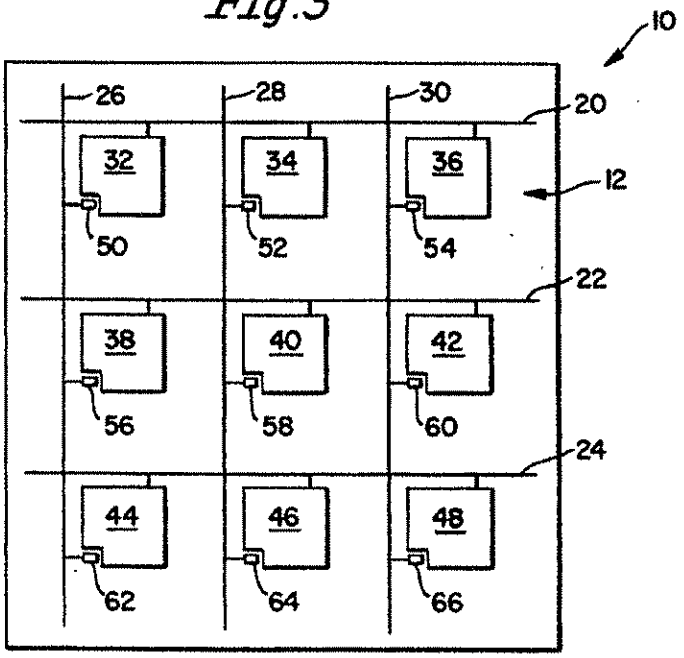

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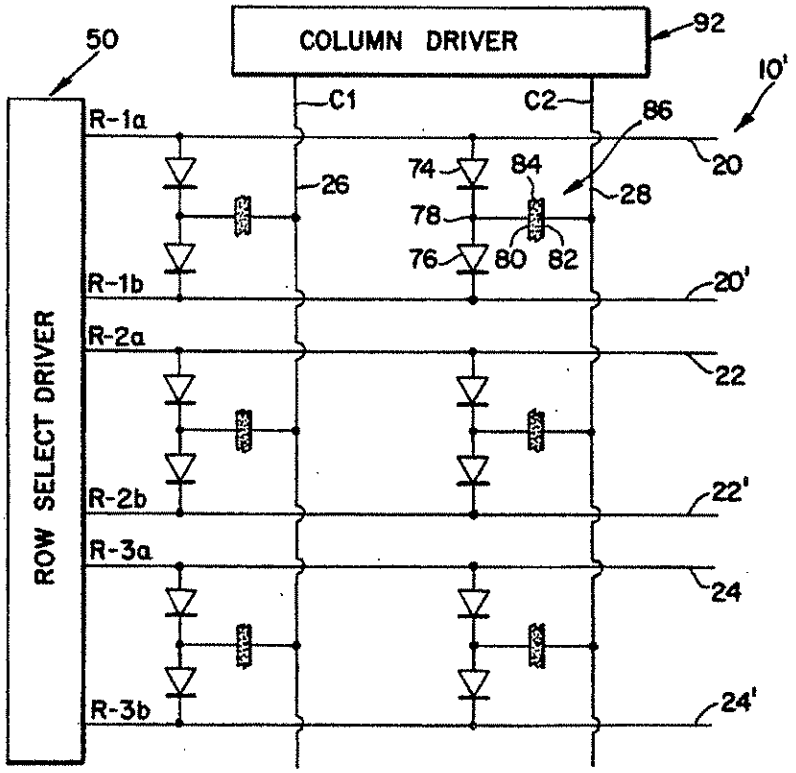
Fig.4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C1
C2
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R-1a
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ROW SELECT DRIVER
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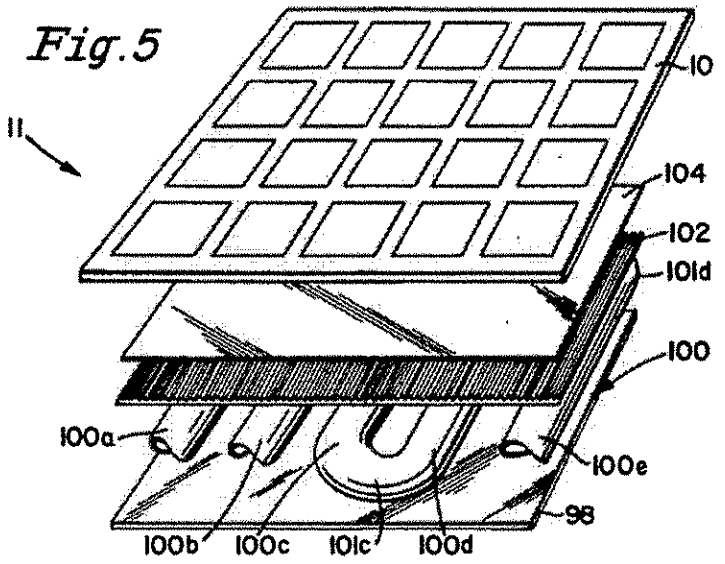
R-3a
24
R-3b
24'

Fig. 5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100d

Fig. 6

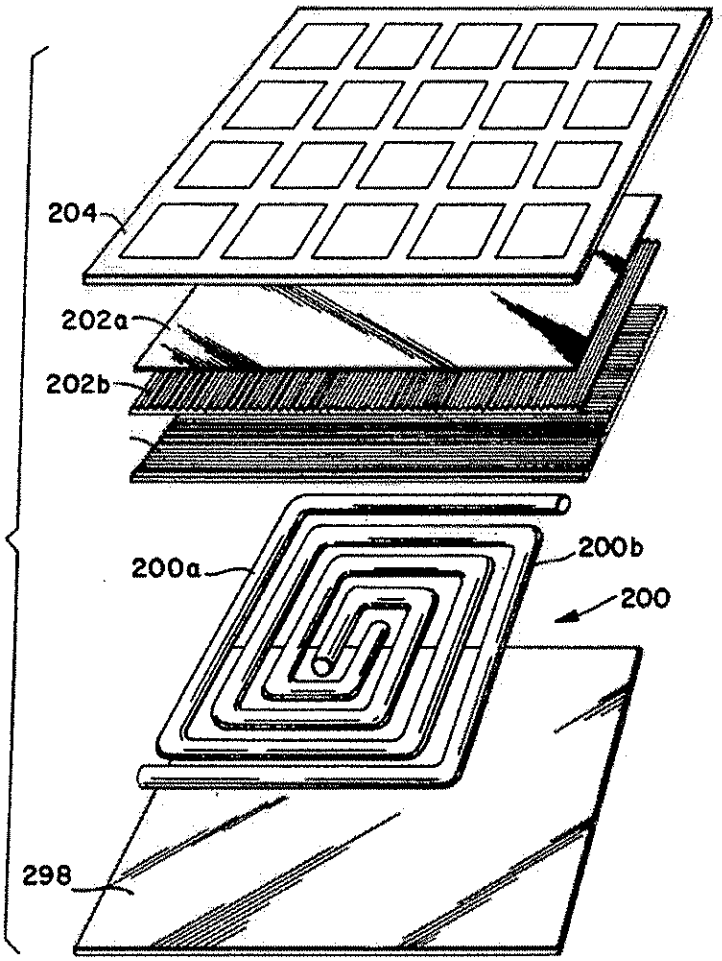
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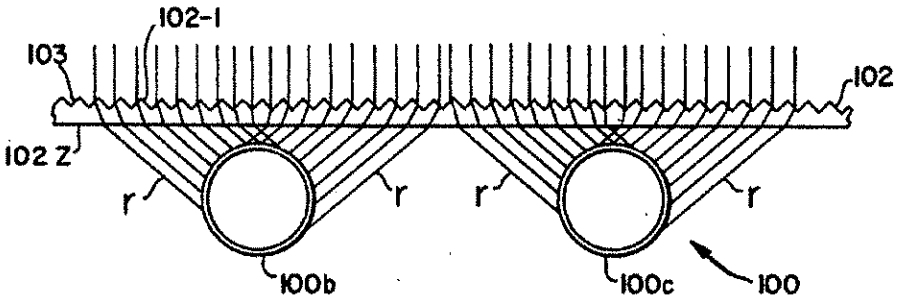
Fig. 7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102 Z
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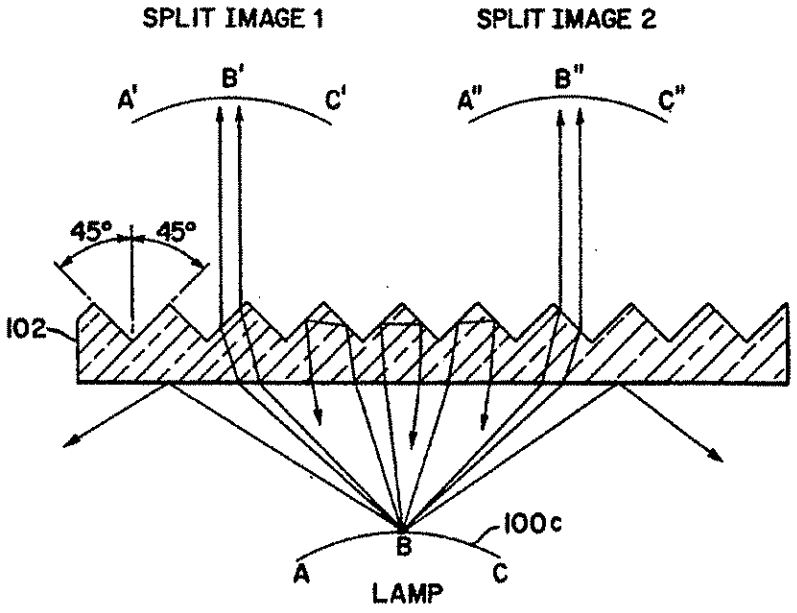
100b
100c
100

Fig. 8


EYE


SPLIT IMAGE 1
SPLIT IMAGE 2
A'
B'
C'
A"
B"
C"
45°
45°
102
100c
A
B
C
LAMP

LIGHTING ASSEMBLY FOR A BACKLIT ELECTRONIC DISPLAY INCLUDING AN INTEGRAL IMAGE SPLITTING AND COLLIMATING MEANS

FIELD OF THE INVENTION

The instant invention relates generally to the field of electronic two dimensional liquid crystal displays, which displays are adapted to provide either still or video images to a remotely positioned viewing audience. The instant invention more particularly relates to the field of backlit liquid crystal displays particularly adapted for military and avionic applications and which are specially designed to present a bright, uniform distribution of light to said viewing audience in a low profile, i.e., minimum depth assembly.

The unique and improved backlit module disclosed in the instant specification finds an important use in full color active matrix liquid crystal displays, particularly those adapted for military and avionic use. This module achieves about one order of magnitude improvement in a figure of merit (FOM) described by the function: FOM =(lamp power/viewing angle) * (backlight thickness/ lamp life), which improvement has been achieved by decreasing the needed lamp power thereby resulting in an increase in lamp life. Additionally, the lighting arrangement set forth in the instant invention features a redundant configuration, intense illumination, uniform illumination, thermal control of the lamps and thin packaging.

BACKGROUND OF THE INVENTION

In recent years, a considerable amount of research has been conducted in an effort to develop a low profile (thin), full color, electronic display system which does not rely upon conventional cathode ray tube technology. In systems such as television receivers, computer monitors, avionic displays, aerospace displays, and other military-related displays, the elimination of cathode ray tube technology is desirable for several reasons, which reasons will be detailed in the following paragraphs.

More particularly, cathode ray tubes are typically characterized by extremely large depth dimensions and thus occupy a considerable amount of floor or counter space. As a matter of fact, the depth dimension may equal the length and width dimensions of the viewing screen. Also, because cathode ray tubes require an elongated neck portion to provide for the acceleration of an electron beam from the electron gun to the faceplate of the cathode ray tube, they are quite irregular in shape. Additionally, since cathode ray tubes are fabricated from relatively thick glass, they are inordinately heavy, extremely fragile and readily breakable. Finally, cathode ray tubes require a relatively high voltage power supply in order to sufficiently accelerate the electron beam and thus sustain the displayed image.

The reader can readily appreciate the fact that all of the foregoing problems experienced with or shortcomings of cathode ray tubes are exacerbated as the size of the viewing screen increases. Since the current trend, and in fact consumer demand, is toward larger screens; weight, breakability, placement, etc. represent significant commercial considerations. Accordingly, it should be apparent that cathode ray tubes are and will continue

to be inappropriate for those applications in which weight, fragility and portability are important factors.

One system which can eliminate all of the aforementioned shortcomings of the present day cathode ray tube is the flat panel liquid crystal display in which a matrix array of liquid crystal picture elements or pixels are arranged in a plurality of rows and columns. Liquid crystal displays may typically be either reflective or transmissive. A reflective display is one which depends upon ambient light conditions in order to be viewed, i.e., light from the surrounding environment incident upon the side of the display facing the viewer is reflected back to the viewer. Differences in the orientation of the liquid crystal material within each liquid crystal pixel cause those pixels to appear either darkened or transparent. In this manner, a pattern of information is defined by the two dimensional matrix array of darkened (or transparent) pixels. However, and as should by now be apparent, reflective liquid crystal displays cannot be used in a dark or low light environment since there is no light available for reflection off the viewing surface of the display.

Conversely, transmissive liquid crystal displays require the use of illuminating means such as a lamp array operatively disposed on the side of the matrix array of picture elements opposite the viewer. This illumination means or backlight may further include a backreflector adapted to efficiently redirect any stray illumination towards the matrix array of rows and columns of picture elements, thus ensuring that the displayed image is as bright as possible (given the lighting capabilities and characteristics of the backlighting scheme being employed). The instant invention is specifically directed to the field of backlit, high resolution liquid crystal electronic displays.

The characteristics of the backlighting scheme are very important to both the quality of the image displayed by the matrix array of picture elements of the liquid crystal display and the profile, i.e., the thickness dimension, of that liquid crystal display. Accordingly, a great deal of the aforementioned research in the field of said flat panel electronic displays has been dedicated to the design and fabrication of backlighting systems which optimize certain viewing and structural parameters of those flat panel displays. Characteristics which are acknowledged by experts as the most important in the design of optimized backlighting assemblies include: 1) uniformity across the large surface areas illuminated by the light provided by the backlight, i.e., the intensity of the light must be substantially the same at each pixel of the large area liquid crystal display; 2) high brightness illumination provided by the backlight thus yielding a sharp, readily readable image to a remotely positioned viewing audience; 3) a low profile so that a flat panel liquid crystal display is substantially flat and can be operatively disposed for viewing without occupying an undue amount of available space; 4) the overall design of the backlight which takes into consideration the number, configuration, and redundancy of lamps; 5) the heat effect caused by the number, configuration, redundancy and type of the lamps; and 6) the total power consumed by the lighting scheme which represents an extremely important consideration in hand held (portable) television units.

A number of different backlight configurations, all of which included a plurality of discrete optical components disposed between the plane of the source of backlit radiation and the plane of the matrix array of liquid

crystal pixels, have been designed in an effort to maximize each of the desirable characteristics recited hereinabove. For example, those of ordinary skill in the art of liquid crystal display backlighting have attempted to use light diffusers in an effort to achieve a more uniform distribution of projected light across the entire viewing surface of the liquid crystal display. This technique, while useful for improving the uniformity of projected light, deleteriously affected the intensity of that projected light resulting in light appearing soft or washed-out. Thus, additional lamps were required when such light diffusers were employed, resulting in an increased heating effect upon the display. Further, due to the fact that such light diffusers were, of necessity, positioned an operative distance from both the source of backlighting as well as from the matrix array of liquid crystal pixels, the depth dimension or profile of the electronic, flat panel display was significantly increased.

A second technique employed to enhance the quality of the backlight (and hence the quality of the displayed image) is to operatively dispose a light collimating lens, such as a fresnel lens, between the source of the backlight and the matrix array of liquid crystal picture elements. This design expedient has the effect of producing an intense, sharp image from a minimal number of lamps, while simultaneously providing a high degree of uniformity of projected radiation across the entire viewing surface of even large area displays. However, due to the nature of collimated light, the viewing angle of a display equipped with such a light collimating lens is limited. Indeed, viewing of the displayed image is impossible from any angle other than directly straight-on. Accordingly, a backlit display which employs only a light collimator without a mechanism for increasing the viewing angle has limited commercial applicability, and is wholly inappropriate for the gigantic markets related to television and computer monitors. Additionally, collimating means, such as fresnel lenses, are characterized by an operative focal length. (The focal length is that distance from the light source at which said lens must be disposed in order to properly collimate light emanating from said light source.) Thus, the light collimator has the undesirable effect o increasing the profile of the liquid crystal display. Also, backreflectors are inappropriate for use with light collimating. This is because light reflected from the backreflector does not originate from a position which is at the focal length of the collimating lens. Hence, light reflected from said backreflector will not be collimated. This results in localized bright spots on the surface of large area displays, degrading the quality of the displayed image.

In a effort to achieve the advantages of both light collimation and light diffusion, routineers in the backlit, flat panel liquid crystal display art have attempted to incorporate both a discrete light diffuser and a discrete light collimator into the same backlit liquid crystal display. Optically speaking, the results have been satisfactory only to the extent that the quality of the displayed image is relatively sharp, intense and uniform; while said image is visible over a relatively wide viewing angle. However, in order to maximize the optical effect of utilizing the diffuser-collimator combination, it was necessary to operatively space the collimator from the source of backlighting radiation, and then to space the diffuser from both the plane of the collimator and the plane of the matrix array of liquid crystal pixels. The result was a substantial increase in the profile, i.e., the depth dimension of the liquid crystal display. Indeed, in typical liquid low profile crystal display systems which include both a light collimator and a light diffuser, the distance from the light source to the diffuser is approximately 17 millimeters. It can thus be seen that by including both diffusing and collimating optical components, the profile of a typical flat panel liquid crystal display is significantly increased, thus eliminating one of the principle advantages of liquid crystal display systems; i.e., compactness. One method of reducing the depth profile and providing the foredescribed improved optical effect is disclosed in copending United States patent application No. 473,039, filed Jan. 31, 1990, assigned to the assignees of the instant application, the disclosure of which is incorporated herein by reference.

While the commonly assigned and copending application improved the profile and optical characteristics of prior art electronic displays having a given figure of merit for intensity of illumination per unit area, that application did not deal with improvements in the lighting efficiencies so as to reduce the number of lamps, the thermal effects of those lamps and the power consumption of those lamps. Accordingly, there still exists a need in the flat panel liquid crystal display art for an improved lighting/optical arrangement which provides a bright, uniform image of high contrast and capable of being viewed over a wide viewing angle, while maintaining a narrow profile and minimizing power consumption and thermal inconveniences.

BRIEF SUMMARY OF THE INVENTION

There is disclosed herein an improved backlit electronic display and specifically a liquid crystal display adapted to provide an image to one or more remotely positioned observers. The improved liquid crystal display is defined by a matrix array of rows and columns of liquid crystal picture elements spacedly disposed from one side of a light source, and means for collimating light operatively disposed between said light source and said rows and columns of liquid crystal picture elements. The improvement in the display of the instant invention residing in the incorporation therein of an image splitting means adapted to enlarge the area effectively illuminated by said light source, said image splitting means and said collimating means forming an integral image splitting/collimating lens. In this manner, a bright, uniform distribution of light is provided in a low profile display.

The display preferably includes a backreflector which is operatively disposed on the side of the light source opposite the image splitting/collimating lens. The display preferably further includes means for diffusing light emanating from the light source, the light diffusing means operatively disposed between said image splitting/collimating lens and said rows and columns of liquid crystal picture elements. In one preferred embodiment, the light source is configured as a single, elongated, serpentine, tubular lamp arranged in a series of elongated parallel lobes. In a second, equally preferred embodiment, the light source may be configured as a plurality of discrete tubular lamps, said lamps defining a given lighting configuration. Regardless of whether the light source defines a lighting configuration formed of a single elongated tubular lamp or a plurality of discrete lamps, said image splitting/collimating lens will comprise a substantially planar thin film sheet having multi-faceted prisms formed on one surface thereof.

The prisms formed on said image splitting/collimating lens are operatively disposed so as to provide an image splitting effect in one dimension of the sheet. In alternative embodiments, the image splitting/collimating film may either be laminated onto a substrate or actually formed thereupon. The substrate is thin and transparent and formed of glass, a ceramic or a synthetic plastic resin. Regardless of the material from which the substrate is fabricated, the direction in which the image splitting/collimating lens is adapted to split radiation corresponds to the longitudinal dimension of the light source. More specifically, rays of light emanating from said light source are refracted on each side of said image splitting/collimating lens to provide two similar images thereof. Of course, the distance between the two similar images is controlled by the operative spacing of s id image splitting/collimating means from said light source. In a preferred embodiment, the image splitting/collimating means is operatively spaced from said light source so that said two similar images are operatively disposed immediately adjacent to one another.

It must be emphasized that the improved backlighting arrangement of the instant invention will operate with equal effectiveness in passive displays as well as in active matrix electronic displays. In such active matrix liquid crystal displays, each picture element will include a pair of electrodes having liquid crystal material operatively disposed therebetween and at least one threshold device. The threshold devices may either be diodes or field effect transistors. Where two threshold devices are employed, they are electrically coupled together at a common node in non-opposing series relationship. The threshold devices preferably comprise diodes formed from deposited thin film layers of amorphous silicon alloy material of p-i-n construction.

In one final embodiment of the invention, the light source can be defined by a plurality of lamps operatively disposed in two orthogonal directions. In such an embodiment, it is necessary to employ a set of two image splitting/collimating lenses. One of those image splitting/collimating lenses will be operatively disposed on top of the second and offset by 90 degrees therefrom. This combination of image splitting, light collimation and light diffusion provides for a thin and efficient assembly which yields a uniform distribution of light over the large surface areas of the display.

These and other objects and advantages of the instant invention will become apparent to the reader from a perusal of the Detailed Description Of The Invention, the Drawings and the claims, all of which follow immediately hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an exploded perspective view illustrating the component elements typically present in a liquid crystal display adapted for use in military and avionic applications;

FIG. 2A is a graph of light intensity distribution in which the intensity of illumination is plotted o the ordinate and the horizontal position across the viewing surface of an electronic display of the type illustrated in FIG. 1 is plotted on the abscissa;

FIG. 2B is a graph of light intensity distribution in which the intensity of illumination is plotted on the ordinate and the horizontal position across the viewing surface of an electronic display of the type illustrated in FIG. 1, including a reflector, is plotted on the abscissa;

FIG. 2C is a graph of light intensity distribution in which the intensity of illumination is plotted on the ordinate and the horizontal position across the viewing surface of an electronic display is plotted on the abscissa, and illustrating in curve I a conventional backlighting arrangement and in curve I' the improved backlighting arrangement of the instant invention;

FIG. 3 is a stylistic front elevational view of the matrix array of rows and columns of liquid crystal picture elements of the active matrix embodiment of the electronic display o the instant invention schematically illustrating the manner in which the threshold switching elements are operatively disposed between the address lines and one of the picture element electrodes;

FIG. 4 is an equivalent circuit diagram of the active matrix embodiment of the array of FIG. 3, illustrating the relationship between the liquid crystal picture elements and the anode-to-cathode connected diodes by which individual ones of the picture elements schematically depicted in FIG. 3 are addressed;

FIG. 5 is a fragmentary perspective view illustrating the relative disposition of one preferred embodiment of the image splitting/collimating lens array of the instant invention relative to a first embodiment of an axially aligned array of tubular lamps;

FIG. 6 is a fragmentary perspective view illustrating the relative disposition of the image splitting/collimating lens array of the instant invention relative to a second embodiment of a square helical array of tubular lamps; and

FIG. 7 is a cross-sectional view of FIG. 5 and illustrating the manner in which rays of light emanating from the axially aligned lighting configuration of FIG. 5 are split and collimated by the optical media of the image splitting/collimating lens array of the instant invention.

FIG. 8 is a partial cross-sectional schematic view of FIG. 7 illustrating the manner in which the rays of light emanating from the light source are refracted on each side of the integral image splitting/collimating lens to provide two similar images thereof.

DETAILED DESCRIPTION OF THE INVENTION

Disclosed as part of the instant invention is an improved backlighting assembly for an electronic display, such as a liquid crystal display and most specifically, by way of example and not by way of limitation, to an active matrix liquid crystal display for military and avionic applications. Active matrix liquid crystal displays, which operate in full color and in the transmissive mode, represent the primary choice of flat panel technologies for avionic and military applications because of their sunlight readability, high resolution, color and gray scale capability, low power consumption and thin profile. It is to be specifically noted that while an active matrix liquid crystal display will be described in detail hereinafter as a preferred embodiment, the instant invention can be used with equal advantage in any type of backlit electronic display known to routineers in the art. Therefore, the improved backlighting assembly described herein is adapted to enhance lighting parameters such as brightness, redundancy of lamps, low heat effects, while simultaneously providing a low profile to the overall depth dimension of the display structure. With the foregoing objectives clearly in mind, the improved assembly will be described in greater detail in the following paragraphs.

In order for electronic displays to gain increased acceptance in military and avionic applications, the backlighting of flat panel displays, and particularly active matrix liquid crystal displays, must be improved in light efficiency and reliability. In order for a full color liquid crystal display to possess acceptable contrast under high ambient lighting conditions, the backlighting arrangement must be bright. While current backlighting systems have the requisite light output, they still require high power (on the order of 2.4 watts/square inch) and a depth dimension of about two inches. In contrast thereto, the backlight assembly of the instant invention consumes only about 1.2 watts/square inch of power with a depth dimension of only about one inch. In addition, this design increases lamp life, a critical parameter in the design and successful marketing of electronic displays, to approximately 8,000 hours or more from the typical values of about 4,000 hours exhibited by prior art lighting arrangements.

Liquid crystal displays operate as light modulators and do not emit light. Therefore, liquid crystal displays rely upon ambient illumination or backlighting to provide the light necessary for reading. Active matrix liquid crystal displays use a twisted nematic liquid crystal material and two polarizers as the optical components in the modulating mechanism. These materials, together with the color filters, result in a color display panel which can only transmit about 5% of radiation incident thereupon. Therefore, a bright backlight is necessary in order for full color displays to be clearly readable in bright ambient environments.

All backlighting assemblies designed for active matrix liquid crystal display applications have the same basic components. More specifically, each backlighting assembly includes a light source, an optical system comprising one or more lenses for altering the nature of the light emanating from said light source, and light source control electronics (ballast). An exploded perspective view of a fluorescent lamp-based backlight assembly is illustrated in FIG. 1. The backlight assembly depicted therein is represented generally by the reference numeral and, as is typical in the industry, employs a tubular fluorescent lamp 2 as the light source. Of course, the lamp 2 may be arranged in any one of a plurality of well known configurations: it may be serpentine as shown in FIG. 1, alternatively the lamp may be "U-Shaped", or straight.

Returning now to FIG. 1, the typical backlight system further includes a backreflector 3, a lens element 4, and a diffuser 5. Of course, disposed in front of the backlight assembly 1 is a display element comprising a plurality of rows and columns of liquid crystal picture elements adapted to be illuminated by said backlight assembly. The purpose of the backreflector 3 is to redirect light which is not initially directed towards the display element so that the maximum amount of light available from a given light source is directed towards the display 6.

Generally speaking, the optical element 4 is provided to alter or enhance the quality of the light emanating from the light source. While the optical element is an important, indeed necessary, component of the backlight system, it is often the primary cause of increased profile (i.e., increased thickness) in a liquid crystal display system. This is due to the fact that in order to achieve the desired optical effect, it is often necessary to operatively space the plurality of lenses which make up the optical element a preselected distance from one another. For example, a collimating lens such as a Fresnel lens is characterized by a focal length which defines the operative spacing from the light source necessary for the lens to effectively collimate the light. This spacing, along with the operative spacing required by, for example a diffuser significantly increases the profile of the backlight assembly.

It is to the end of reducing the profile of the liquid crystal display system that the instant invention is directed. This is accomplished by incorporating two necessary optical components, an image splitting lens and a collimating lens into a single, integral image splitting-/collimating lens. More particularly, the instant invention includes an image splitting lens for effectively doubling the area which the light source can uniformly and effectively illuminate. The image splitting lens is however further adapted to collimate the light emanating from the lamp 2 for uniform distribution onto the back of the matrix forming the liquid crystal display 6. There are several ways to obtain light collimation, such as, for example, through the use of various combinations of parabolic shaped reflectors and lens elements. However, the image splitting means of the instant invention is adapted to collimate light passing therethrough due to the presence of multi-faceted prisms formed on the surface thereof. Specifically, engineered facets of close tolerances will not only achieve the desired optical effect of splitting the image of the light source, but will also collimate each image.

The instant inventors have found that a material ideally suited for use as an image splitting/collimating lens is Optical Lighting Film (registered Trademark of 3M Scotch) which is subsequently laminated onto a transparent substrate such as glass, other ceramic or a synthetic plastic resin. By employing an integrally formed image splitting/collimating lens it is thus possible to achieve two desired optical effects with a decrease in the profile of the display as compared to other non-integrally formed optical systems. Indeed, since the distance between the two similar images provided by the image splitting lens is controlled by the operative spacing of the lens from the light source (i.e, the more distant the lens from the light source, the farther apart said two images appear) and since it is desired that the distance between the two images be controlled so that said two images are immediately adjacent one another, it is possible, indeed desirable to dispose the image splitting-/collimating lens in close proximity to the light source 2.

Returning now to FIG. 1, a diffuser 5 is provided to scatter the collimated light so that it will illuminate the display matrix 6 in all directions and provide acceptable off axis (wide angle) viewing. However due to the high degree of uniformity of light provided by the image splitting/collimating lens it is not necessary to diffuse the light to the extent necessary in prior art backlight assemblies, and thus the profile of the backlight assembly is further reduced. The backlight assembly 1 further includes lamp control electronics having provisions for lamp starting, a ballast 7 and dimming circuitry.

The light output of the light source 2 disposed behind prior art assemblies such as the liquid crystal display 6 of FIG. 1 is not uniform and will be dependent upon the configuration of the lamps employed and the type of optical system if any, employed. FIG. 2A illustrates the distribution of light intensity directly in front of the serpentine arrangement of fluorescent lamps 2 depicted in FIG. 1, as unenhanced by an optical system (i.e.,

without any collimating, image splitting or diffusing elements). As can be easily discerned from FIG. 2A, unenhanced light emanating from the light source will inevitably lead to areas of localized high intensity of illumination on the array of liquid crystal pixels. This, of course, results in local bright spots, such as b, and local pale spots, such as p, in the displayed image and therefore degraded image quality.

Of course, it is one of the purposes of an optical system, such as 4 in FIG. 1, to redistribute the intensity of radiation from the high intensity areas to the areas of lower intensity while maintaining the total integrated light output from the lamp assembly 2. FIG. 2B depicts the typical distribution of light intensity of the serpentine arrangement of fluorescent lamps 2 of FIG. 2A to which a backreflector 3 has been added. Acceptable uniformity across the viewing surface of the liquid crystal display requires optimization of the backreflector 3 in conjunction with the other optical components. Current backlighting arrangements have been configured to provide acceptable uniformity thereacross, but they lose about one-half of the energy emanating from the lamps. The curve marked as I in FIG. 2C illustrates an intensity of illumination that can be expected from current backlighting designs. In the detailed description which follows hereinafter, a highly efficient optical system will be disclosed that maximizes light output while achieving a high degree of uniformity across the viewing screen, in the manner shown by the curve I'.

The lamp and optical configurations are critical elements in the design of such systems because the characteristics thereof determine the final performance parameters and the overall structural profile of the display. In achieving an optical system characterized by such performance, fluorescent lamps will be capable of operation at a substantially reduced power level, which results in prolonged life. This also reduces heat build-up, thereby reducing thermal management requirements and permitting a more compact design. These improvements not only result in an improved backlighting arrangement in terms of uniformity and intensity, but one that is more reliable and less expensive to build and maintain.

Referring now to FIG. 3, there is depicted therein a matrix array of rows and columns of discrete liquid crystal display picture elements, said matrix array being generally designated by the reference numeral 10. Each liquid crystal display picture element, or pixel, 12 includes two spacedly disposed pixel electrode plates with a light influencing material, such as a liquid crystal composition, operatively captured therebetween. (The electrode plates and the light influencing material will be discussed in detail with respect to FIG. 5.) Each of the pixels 12 further includes a threshold switching device or a plurality of threshold switching devices for selectively applying an electric field across the liquid crystal composition when the electric field exceeds a predetermined threshold value.

More specifically, the matrix array 10 which defines the liquid crystal display of the instant invention includes a first set of X address lines 20, 22 and 24: a second set of Y address lines 26, 28 and 30; and a plurality liquid crystal picture elements 32, 34, 36, 38, 40, 42, 44, 46 and 48. The display further includes at least one isolation or addressing element 50, 52, 54, 56, 58, 60, 62, 64 and 66 operatively associated with and electrically connected to each respective one of the picture elements. As should be readily apparent to the reader from even a cursory review of FIG. 1, the X address lines 20, 22 and 24 and the Y address lines 26, 28 and 30 cross over one another at an angle so as to define a plurality of spaced crossover points associated with respective ones of the liquid crystal picture elements 32-48. The picture elements are formed on a transparent substrate, such as glass, and are distributed thereover in spacedly disposed relation so as to define interstitial spaces therebetween.

As can be ascertained from a perusal of FIGS. 3 and 4, each of the threshold devices 50-66 is preferably coupled in nonopposing series relation with a first one of the pixel electrodes. This type of switching arrangement will now be described in greater detail with respect to FIG. 4. In FIG. 4, the matrix array 10' includes a plurality of substantially parallel address line pairs 20, 20', 22, 22', 24 and 24' which are the row select lines and a plurality of substantially parallel column address lines 26 and 28. The column address lines 26, 28, and 30 cross the row select address line pairs at an angle and are spaced from the row select address line pairs to form a plurality of crossover points therewith. Preferably, the column address lines cross the row select line pairs at an angle which is substantially perpendicular thereto.

Since, as mentioned hereinabove, each of the pixels are identical, only pixel 12 will be described in detail in the following paragraphs. Pixel 12, as can be seen from the figures, includes a pair of threshold devices 74 and 76 which are electrically coupled together at common node 78. The threshold devices 74 and 76 are preferably diodes and are electrically coupled together in nonopposing series relationship between the row select address line pair 20 and 20'. Although the threshold devices, in accordance with the preferred embodiment of the invention are diodes, said devices can be of any type which provides a high impedance to current flow when reverse biased and a comparatively low impedance to current flow when forward biased. Therefore, any bidirectional threshold switch or field effect transistor can be utilized with equal advantage. Of course, more conventional electrical interconnections would be employed with field effect transistors.

The picture element or pixel 12 further includes a pair of electrode plates 80 and 82 which are spaced apart and facing one another. Operatively disposed in the space between the electrodes 80 and 82 is a light influencing material 84. The term "light influencing material" is defined and will be used herein to include any material which emits light or can be used to selectively vary the intensity, phase, or polarization of light either being reflected from or transmitted through the material. In accordance with the preferred embodiment of the invention, the light influencing material is a liquid crystal display material, such as a nematic liquid crystal material. In any event, the electrodes 80 and 82 with the liquid crystal material 84 disposed therebetween form a storage element 86 (or capacitor) in which electric charge can be stored. As illustrated, the storage element 86 is coupled between the common node 78, formed by the electrically connected diodes 74 and 76, and the column address line 26.

Still referring to FIG. 4, the display 10 further includes a row select driver 90 having outputs R-1*a*, R-1*b*, R-2*a*, R-2*b*, R-3*a*, and R-3*b* electrically coupled to the row select line pairs 20, 20', 22, 22', 24, and 24'. The row select driver 50 provides drive signals at the outputs thereof to apply first operating potentials which are substantially equal in magnitude and opposite in polar-

ity between the row select address line pairs to forward bias the threshold devices to in turn facilitate the storage of electric charge in the storage elements coupled thereto. The row select driver also applies second operating potentials which are substantially equal in magnitude and opposite in polarity between the row select address line pairs to reverse bias the threshold devices to facilitate the retention of the electric charge stored in the storage elements coupled thereto.

Lastly, the electronic display **10** includes a column driver **92**. The column driver **92** includes a plurality of outputs, C1 and C2, which are coupled to the column address lines **26** and **28** respectively. The column driver is adapted to apply a charging potential to selected ones of the column address lines for providing electric charge to be stored in selected storage elements during the application of the first operating potentials to the row select address line pairs by the row select driver **50**.

It is preferred that the matrix array of rows and columns of picture elements that combine to make up the improved electronic display **10** of the instant invention utilize a "balanced drive" scheme for addressing each discrete one of the pixels thereof. In this driving scheme, the operating potentials applied to the row select address line pairs are always substantially equal but opposite in polarity. Assuming that the current-voltage characteristics of each of the diodes are substantially equal, a voltage of substantially zero volts will be maintained at the common node **78**, at least when the diodes are forward biased. Thus, the voltage applied on the column address line **26** to charge storage element **86** no longer needs to take into account the voltage drop across and/or parasitic charge build-up on one or both of the diodes **74** and **76**. Therefore, each pixel in the matrix array of rows and columns may be charged to a known and repeatable value regardless of its position in that matrix array. This permits improved gray scale operation resulting in at least **15** levels of gray scale in large area active matrix displays of the twisted nematic liquid crystal type using normal fluorescent back illumination. The pixels can also be charged more rapidly since the retained charge in the diodes associated with each pixel when they are reverse biased need not be initially dissipated to charge the storage elements. This is because this charge is dissipated when the diodes are first forward biased. A complete description of this driving scheme can be found in U.S. Pat. No. 4,731,610 issued on Mar. 15, 1988 to Yair Baron et al and entitled "Balanced Drive Electronic Matrix System And Method Of Operating The Same", the disclosure of which is incorporated herein by reference.

Turning now to FIG. **5**, there is depicted in a fragmentary perspective view, one preferred embodiment of the instant invention. In this embodiment of the invention, the image splitting/collimating lens **102** is operatively disposed so as to provide for a low profile electronic display assembly **11**. The low profile or depth dimension of the display is especially important and is dependent on the type of lighting assembly, the material from which the threshold devices are fabricated, the on-board electronics, the multiplexing schemes, and most importantly, the optical arrangement by which light is diffused, collimated and transmitted to the viewing audience. It is, inter alia, the depth dimension of liquid crystal displays that has been significantly improved by the inventive concept set forth herein.

There are four basic elements which combine to form the electronic display **11** depicted in FIG. **5**. The uppermost element is the generally rectangularly-shaped glass panel **10** upon which the rows and columns of active matrix liquid crystal picture elements as well as the associated drive circuitry, described in the preceding paragraphs, are disposed. The lowermost element is the thin, generally rectangularly-shaped back reflector panel **98** upon the interior surface of which one or more thin film layers of highly reflective material, such as aluminum or silver and a light transparent material having a low index of refraction, are deposited. Disposed immediately above the highly reflective panel **98** is an array of light sources **100** from which radiation emanates and either passes directly towards the matrix array of picture elements or is reflected off of the highly reflective panel and then passes upwardly toward said matrix array. Finally, the improved image splitting/collimating lens **102** of the instant invention is operatively located between the array of light sources **100** and the matrix array of picture elements **10**. It is the combination of these elements which define the profile, preferably the low profile, of the electronic display of the instant invention.

More specifically, it is important to note that lighting is one of the critical parameters which is employed in assessing the visual appearance of a liquid crystal display. Not only is it essential that the image of the display appear clear and bright to the viewers thereof, but it is also important that the image be substantially as clear to viewers disposed at an angle relative to the vertical plane of the viewing screen of the display. The structural and optical relationship existing between the array of light sources and the image splitting/collimating lens **102** helps to determine the clarity and viewing angle of the display.

In the preferred embodiment of the invention illustrated in FIG. **5**, the array of light sources **100** is configured as one elongated, serpentine fluorescent lamp (although it must be appreciated that a plurality of discrete elongated tubular lamps could be employed without departing from the spirit or scope of the instant invention) arranged in a specific pattern or lighting configuration and having each section of lamp disposed in a generally horizontal plane. More specifically, the array, regardless of configuration, will be arranged to uniformly distribute radiation emanating therefrom over the entire surface area of the matrix of rows and columns of picture elements **105**. To this end, the lighting array is shaped in a serpentine pattern which may include a plurality of elongated lamps, such as **100***a*–**100***e*, each lamp of which has a longitudinal axis parallel to the longitudinal axis of the other major lamp sections The length of each longitudinal lamp axis is generally coextensive with the length dimension of the matrix array of picture elements. The configuration of the lighting array **100** also includes curved end sections, such as **101***c*–**101***d*. The number of the elongated axial sections of the lamps and the number of the curved end sections of the lamps must be sufficient to bathe the entire width dimension of the matrix array of picture elements **105** with a uniform shower of illumination.

The image splitting/collimating lens **102** is formed as an integral unit, vis-a-vis, prior art image splitters and collimators which were formed as two distinct elements. The integrally formed image splitting/collimating lens is, as discussed hereinabove, fabricated of Optical Lighting Film (registered Trademark of 3M Scotch) which is subsequently laminated onto a transparent substrate such as glass, a ceramic or plastic. By employ-

ing an integrally formed image splitting/collimating lens it is thus possible to achieve two desired optical effects without an increase in the profile of the display. Indeed, since the distance between the two similar images provided by the image splitting effect of the image splitting/collimating lens is controlled by the operative spacing of the lens from the light source (i.e, the more distant the lens **102** from the light source, the farther apart said two images appear) and since it is desired that the distance between the two images be controlled so that said two images are immediately adjacent one another, it is possible, indeed desirable, to dispose the image splitting/collimating lens in close proximity to the light source **100**. As is illustrated in FIG. **5**, the image splitting/collimating lens can be used in conjunction with a diffuser **104** to further enhance the uniformity of the light emanating from the light source **100**.

In a second preferred embodiment of the invention illustrated in FIG. **6**, the array of light sources **200** is configured as square, helical fluorescent lamp (although it must be appreciated that a plurality of discrete elongated tubular lamps could be employed without departing from the spirit or scope of the instant invention) arranged in a specific pattern or lighting configuration and having each section of lamp disposed in a generally horizontal plane. As stated hereinabove, the array, regardless of configuration, will be arranged to uniformly distribute radiation emanating therefrom over the entire surface area of the matrix of rows and columns of picture elements **205**. To this end, the lighting array is shaped in a square, helical pattern which may include at least a pair of squarely configured, elongated lamps, such as **200***a*–**200***b*, each portion of each squarely configured lamp being parallel to the squarely configured portions of the other lamp. The configuration of the lighting array **200** also includes curved sections, such as **201***c*–**201***d*. The number of the elongated portions of the lamps is generally equal to eight in the square helical configuration.

The image splitting/collimating lens **202** is formed as an integral unit, vis-a-vis, prior art image splitters and collimators which were formed as two distinct elements. The integrally formed image splitting/collimating lens is, as discussed hereinabove, fabricate of Optical Lighting Film (registered Trademark of 3M Scotch) which is subsequently laminated onto a transparent substrate such as glass, a ceramic or plastic. By employing an integrally formed image splitting/collimating lens it is thus possible to achieve two desired optical effects without an increase in the profile of the display. Indeed, since the distance between the two similar images provided by the image splitting effect of the image splitting/collimating lens is controlled by the operative spacing of the lens from the light source (i.e, the more distant the lens **202** from the light source, the farther apart said two images appear) and since it is desired that the distance between the two images be controlled so that said two images are immediately adjacent one another, it is possible, indeed desirable, to dispose the image splitting/collimating lens in close proximity to the light source **200**. As is illustrated in FIG. **6**, the image splitting/collimating lens can be used in conjunction with a diffuser **204** to further enhance the uniformity of the light emanating from the light source **200**.

Turning now to FIG. **7**, there is depicted therein a cross-sectional view of FIG. **5**, said cross-sectional view provided to demonstrate the manner in which rays of light "r" emanating from the lamps **100***b*–**100***c* of the lighting configuration **100** are collimated to present a sharp image to the viewing audience of the liquid crystal display of the instant invention. More particularly, there is depicted a plurality of lamps, such as **101***b*, **101***c*, and **101***d*, of the embodiment of the lighting configuration wherein the longitudinal axes thereof are disposed in substantially parallel alignment. As can be seen from a perusal of FIG. **7**, the rays of light "r" emanating from the three parallel, but spacedly disposed lamps are directed upwardly through the relatively thin image splitting/collimating lens **102**. The upper surface, the surface opposite the light source **100**, of the image splitting/collimating lens **102** is engineered so as to comprise a series of aligned multi-faceted prisms **103**. The prisms **103** are aligned such that the longitudinal extents thereof are substantially parallel to the longitudinal extents of the substantially parallel lamps **100***a* and **100***b*. At both the planar air-to-material interface **102***z* and the faceted L material-to-air interface **102***y* thereof, the rays of light are collimated and transmitted to the viewers in that collimated fashion. Note that for purposes of illustrating the collimating effect of the lens array of the instant invention, neither the reflector plate **98** nor the matrix array **10** of rows and columns of liquid crystal picture elements are depicted in FIG. **7**. Of course, it is the aligned facets of said prisms **103** that provide the image splitting effect which is critical to the improved performance provided by the instant invention.

FIG. **8** is presented to schematically illustrate how the above-referenced aligned facets of the prisms **103** inherently operate to provide the image splitting effect. This, of course, also illustrates the inherent characteristics of operation of the aforesaid 3M Optical Lighting Film when used in this invention. As illustrated with reference to a segmented arc of lamp **100***c* having a mid-point B and extremities A and C (these points being designated for convenience of illustration, it being understood that lamp **100***c* is a circular tube), certain rays of light are reflected backwardly while others are allowed to exit in collimated fashion from lens **102**. To the observer located at "eye" this inherently results in a "split image" **1** and **2**, the spacking of which, as aforesaid, is governed by the distance between the lamp **100***c*, and the lens **102**.

While the foregoing paragraphs have described the inventive concept set forth in the this specification, the instant inventors do not intend to have the disclosed invention limited by the detailed embodiments, drawings or description; rather, it is intended that the instant invention should only be limited by the scope of the claims which follow hereinafter, as well as all equivalents thereof which would be obvious to those routineers of ordinary skill in the art.

What is claimed is:

1. In a backlit liquid crystal display which includes a source of light; a matrix array of rows and columns of liquid crystal picture elements spacedly disposed from one side of said light source; and means for collimating light, said collimating means operatively disposed between said light source and said matrix array of rows and columns of liquid crystal picture elements; said liquid crystal display capable of providing an image to a remotely positioned observer; the improvement comprising, in combination:

an integral collimating and image splitting means for collimating light from said light source and for refracting light rays emanating from said light source to provide two similar images thereof,

thereby enlarging the area effectively illuminated by said light source, whereby a bright, uniform, light distribution is provided in a low profile assembly.

2. A display as in claim 1, further including a backreflector operatively disposed on the side of said light source opposite said image splitting/collimating lens.

3. A display as in claim 1, further including means for diffusing light emanating from said light source, said light diffusing means operatively disposed between said image splitting/collimating lens and said rows and columns of liquid crystal picture elements.

4. A display as in claim 1, wherein said light source is a single, elongated, serpentined, tubular lamp arranged in a series of elongated parallel lobes.

5. A display as in claim 1, wherein said light source is a multi-tube lamp array wherein each of said lamps are elongated tubular lamps arranged in substantially parallel fashion.

6. A display as in claim 1, wherein said light source is at least a pair of tubular lamps arranged in a square helical configuration.

7. A display as in claim 1, wherein said image splitting/collimating lens comprises a film having prisms formed on one face thereof.

8. A display as in claim 7, wherein the image splitting/collimating film is laminated to a substrate.

9. A display as in claim 8, wherein said substrate is a thin transparent substrate.

10. A display as in claim 9, wherein the substrate is glass.

11. A display as in claim 1 wherein said integral collimating and image splitting means includes a thin film having faceted prisms formed on one face thereof and wherein said light rays are refracted by the said facets of said prisms.

12. A display as in claim 1, wherein the distance between said two similar images is controlled by the operative spacing of said image splitting/collimating means from said light source.

13. A display as in claim 12, wherein said image splitting/collimating means is operatively spaced from said light source so that said two similar images are immediately adjacent one another.

14. A display as in claim 1, wherein the liquid crystal display is an active matrix liquid crystal display.

15. A display as in claim 1, wherein each liquid crystal picture element comprises a pair of electrodes having liquid crystal material disposed therebetween and at least one threshold device connected at one of the terminals thereof to one of said electrodes.

16. A display as in claim 15, wherein a pair of threshold devices are provided, said threshold devices electrically coupled together at a common node in nonopposing, series relationship.

17. A display as in claim 15, wherein said at least one threshold device comprises a transistor formed from deposited layers of semiconductor material.

18. A display as in claim 15, wherein the threshold devices comprise diodes formed from deposited layers of semiconductor material.

19. A display as in claim 18, wherein the semiconductor material is an amorphous silicon alloy material.

20. A display as in claim 1, wherein the light source comprises lamps arranged in two orthogonal directions.

21. A display as in claim 20, further including two image splitting/collimating lenses arranged to provide perpendicular image splitting effects.

22. A display as in claim 21, wherein said image splitting/collimating lenses each comprise thin films disposed one atop the other, and wherein the dimension in which one of said image splitting/collimating lenses provides an image splitting effect is offset by 90 degrees relative to the other lens.

* * * * *

6.

AMENDMENT AFTER FINAL REJECTION DATED JULY 1, 1993

PATENT

IN UNITED STATES
PATENT AND TRADEMARKS OFFICE

Applicant: Richard I. McCartney, et al) Art Unit: 2504
)
Serial No.: 007/911,547) Examiner: H. Mai
)
Filed: 09 July 1992) Doc. No.:A6213491
)

For: "A DIRECTIONAL DIFFUSER FOR A LIQUID CRYSTAL DISPLAY"

AMENDMENT AFTER FINAL REJECTION

Commissioner of U.S.
Patent and Trademark Office
Washington, D.C. 20231

Dear Sir:

In response to the Office Action mailed on 06 May 1993, please amend the above-identified application as follows:

IN THE CLAIMS

Kindly delete Claims 4, 5, 6 and 10.

Kindly amend Claims 7 and 9 as follows:

Claim 7 (Twice Amended) A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel. [A display apparatus in accordance with Claim 10] wherein said liquid crystal panel comprises a plurality of pixels arranged in rows and columns, and wherein the number of rows of pixels per unit height, or pitch, of the liquid crystal panel is a first value; the number of lenslets per unit height, or pitch, of said first lens array is a second value which is less than said first value; and the number of lenslets per unit height, or pitch, of said second lens array is a third value which is greater than said first value.

Claim 3 (Twice Amended) A display apparatus comprising:

a light source;

a liquid crystal panel mounted adjacent to said light source for receiving light from said light source; and

first and second lens arrays, each having a plurality of individual lenslets, disposed between said light source and said liquid crystal panel for providing a predetermined variation with viewing angle of light transmission from said light source through said lens arrays and said liquid crystal panel. [A display apparatus in accordance with Claim 10]

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wherein at least one of said first and second lens arrays is rotated about an axis perpendicular to said liquid crystal panel in order to provide a slight misalignment between said lenslets and said liquid crystal panel.

REMARKS

The Examiner has finally rejected Claims 4-6 and 10. Applicants have deleted Claims 4-6 and 10.

The Examiner has objected to Claims 7 and 9, indicating that they would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Claims 7 and 9 have been amended as suggested by the Examiner.

The Examiner has objected to Claim 8 as being dependent on an objected claim. Claim 7 has been amended to overcome the noted objection and claim 8, which depends therefrom, should now be allowable.

Applicants having amended Claims 7 and 9 to overcome the Examiner's objections, Claim 8 now depending from allowable Claim 7, and all remaining claims having been canceled, hereby request a Notice of Allowance for Claims 7, 8 and 9, as amended, at the earliest opportunity.

Respectfully Submitted,

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"EXPRESS MAIL" Date of Deposit 7-2-93
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I hereby certify that this paper or fee is being deposited with the United States Postal Service "Express Mail Post Office to Addressee" service under 37 CFR 1.10 on the date indicated above and is addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231
JOANNA JOHNSON
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(Signature of person mailing paper or fee)

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7.

TRANSCRIPT OF TELEPHONE CONFERENCE ON 9/9/2005

THE UNITED STATES DISTRICT COURT
IN AND FOR THE DISTRICT OF DELAWARE

HONEYWELL INTERNATIONAL, INC. et al. : CIVIL ACTIONS
:
Plaintiffs, :
:
v. :
:
AUDIOVOX COMMUNICATIONS CORP., et al. :
: NO. 04-1337 (KAJ)
Defendants. :

HONEYWELL INTERNATIONAL, INC. et al. :
:
Plaintiffs, :
:
v. :
:
APPLE COMPUTER, INC., et al., :
: NO. 04-1338 (KAJ)
Defendants.

Wilmington, Delaware
Friday, September 9, 2005 at 10:40 a.m.
TELEPHONE CONFERENCE

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PROCEEDINGS

REPORTER'S NOTE: The following proceedings were held in open court, beginning at 10:40 a.m.)

THE COURT: Counsel, this is Judge Jordan. I apologize keeping you waiting. The folks who were in the queue ahead of you exceeded their allotted time but we were able to work some things out and I appreciate your patience.

Why don't we go ahead and I'll get a roll call from you folks of who is on the line and who you represent. Okay? Let's start with the plaintiff.

MR. GRIMM: Good morning, Your Honor. It's Tom Grimm at Morris Nichols for Honeywell. On the line with me today; first, Your Honor may recall Honeywell filed two separate actions so on the line with me also is John Day of the Ashby & Geddes firm.

Our co-counsel on the line with us this morning are Martin Lueck, Matt Woods and Stacie Roberts at the Robins Kaplan Miller & Ciresi firm. And also on the line this morning with us is David Brafman, Intellectual Property counsel for Honeywell. And that's for all plaintiff Honeywell.

THE COURT: All right. Let's just start down the list of defendants. Go ahead.

MR. HORWITZ: Your Honor, this is Rich Horwitz at Potter Anderson on behalf of a number of defendants. And with me on the line, I'll go through the list.

THE COURT: Well, you need to tell me which defendants you are here for. I know this is --

MR. HORWITZ: That's fine. I'm on the line for Dell, Fujitsu, Concord Camera, Toshiba, Nikon, Samsung SDI, Sanyo, Wintek and Philips.

And with me on the line for Dell, Rick Williams; for Philips, Alan Grimaldi and Nelson Kee; for Fujitsu, Christopher Chalsen; for Sanyo, Michael Dorfman; for Toshiba, Carl Schlier; for Nikon, Barry Graham; for Wintek, York Faulkner. We are on alone for Concord Camera. And for Samsung SDI, Stephen Komiczky.

MR. LAMPERT: One correction. This is Scott Lampert for Concord Camera.

MR. HORWITZ: I'm sorry, Scott. I didn't realize you were on.

THE COURT: All right. Thanks.

Is there anybody else on?

MR. WADE: Your Honor, it's Bill Wade at Richards Layton & Finger, and I'm on for the Matsushita defendants along with Steve Rizzi and perhaps David Lender from Weil, Gotshal & Manges.

MR. BENSON: Your Honor, this is Robert Benson of Hogan & Hartson on for Seiko Epson and Kyocera Wireless.

MR. KATZENSTEIN: Your Honor, this is Robert Katzenstein. I'm Mr. Benson's local counsel.

MR. HALKOWSKI: Your Honor, this is Tom Halkowski on behalf of Nokia, Apple and Casio. And with me

on the line on behalf of Nokia is Lauren Degnan; and on behalf of Apple, Kelly Hunsaker; and on behalf of Casio, John Johnson and Lewis Hudnell. Thank you.

THE COURT: All right.

MR. ROVNER: Your Honor, this is Phil Rovner for the Fuji Photo Film defendant. With me on the line is Larry Rosenthal from Stroock Stroock & Lavan in New York.

THE COURT: Okay.

MR. ROCHE: Your Honor, Brian Roche in Chicago for Hartford Computer Group.

THE COURT: And is somebody on with you, sir, as local counsel?

MR. ROCHE: No.

THE COURT: Have you arranged for local counsel?

MR. ROCHE: Yes, we have local counsel from Cross & Simon.

THE COURT: All right. Typically, we look for those folks to be on those calls too unless excused. But thanks for identifying yourself.

Who else is on?

MR. SHANDLER: Your Honor, Chad Shandler for Richard Layton for Eastman Kodak. With me on the line is Neal Slifkin from Harris Beach.

THE COURT: Anybody else?

MR. WALSH: Your Honor, Tom Walsh with McCarter

& English on behalf of Audiovox Electronics Corporation.

MR. POFF: Your Honor, Adam Poff from Young Conaway on behalf of the Pentax defendants. And also Michael Fink from Greenblum and Bernstein on behalf of Pentax.

MR. SHAW: Your Honor, John Shaw for the Olympus and Sony defendants, and I believe Richard Rosati and Bob Hails is for Olympus.

MR. ROSATI: Rich Rosati for Olympus.

MR. SHAW: And Bob Hails is for the Sony defendants.

THE COURT: Okay.

MR. OLSEN: Your Honor, James Olsen from Connolly Bove for the Sony Ericsson defendants.

MR. ENGLISH: Your Honor, this is Joe English from Duane Morris on behalf of Audiovox Communications Corp.

THE COURT: And do we have anybody else on?

MR. FLOCK: Your Honor, this is John Flock from Kenyon & Kenyon, also on for Sony corporation.

THE COURT: Thank you.

MS. PASCALE: Your Honor, this is Karen Pascale from Bouchard Margules & Friedlander for Optrex America which is the named plaintiffs in the 04-1536 action; and on the line with me is Andrew Ollis from the Oblong Spivack firm.

THE COURT: Okay. Do I have anybody else?
(Pause.)
THE COURT: All right. Well, thanks for assembling. I'm glad the telephone company has got enough lines to handle this call.
We are together because in spite of what I thought was pretty clear direction a few months ago, we still haven't been able to get plaintiffs and defendants moving forward on this case, and I received a letter on August 22nd from Mr. Grimm saying, "hey, since our correspondence to you in June, we're still at odds."
So, I've taken a look at the correspondence but why don't I give you a chance to tell me what you think the points in dispute are that can't be resolved without my intervention so we can get a scheduling order in place, short of me just imposing one.
Who is speaking on behalf of the plaintiffs on this?
MR. GRIMM: Your Honor, this is Tom Grimm. Marty Lueck of the Robins Kaplan Miller & Ciresi firm will speak.
THE COURT: Mr. Lueck.
MR. LUECK: Good morning, Your Honor. I think I can give you a snapshot here of where we've made progress, where we haven't and I think give the Court an idea of how

we might be able to resolve the logjam so we can transition this case from the customer defendants to the module maker defendants.
Basically, what we have asked for in discovery from the customer defendants is a list of all products sold in the United States in the categories that are set forth in the complaint going back from October 6th, 1998 to the present. And we've asked for the identity of a module maker for each of those products and the LCD module model number. And the reason we've asked for that information is so that we can match up the LCD modules that were manufactured overseas to the end products that were actually imported into the United States and sold because those are the ones that are going to be at issue for both liability and ultimately, down the road, damage.
THE COURT: All right. I'm sorry to interrupt, Mr. Lueck. Give it to me one more time. What is it that you specifically asked for in discovery?
MR. LUECK: What we're asking for is a list of all – and let me just back up. This is for the customer defendants. A list of all products sold in the United States in the categories set forth in the complaint from October 6th, 1998 to the present. And that's consistent with the patent statute of limitations, six years back from the date of filings of the complaint. The products.

THE COURT: All right. Now, before you go further, let me ask you what I took it to be the other side's position and just have you respond to it directly.
I think they were saying to saying to me, these guys should be identifying the products they think infringe in the first instance. Am I right that that is a point of contention or am I wrong about that?
MR. LUECK: You are correct, Your Honor, as to some of the defendants.
THE COURT: What is your response?
MR. LUECK: Our response to that is we have identified all of the products that we have purchased and torn down and found specific instances of infringement. We're unable to buy every product that is out there, and in fact for the products that are in the past, we have no idea whether we would have all of those or not have all of them. And we don't believe on a going-forward basis, it should be our burden to buy every single product of every single company, tear it down and then make an individual charge of infringement.
We have given them all the information we have to date. And, in addition, we have offered to tear down any products they want to send us and we will give them a response on the results of that tear-down. And that really is the logjam right there. We have resolved that issue with

three of the defendants, Nikon, Concord Camera and Fuji. I believe we're close to resolving it with Nokia and Olympus but were unable to make progress with the others.
THE COURT: All right. And what is the basis of your agreement with the ones you have resolved it with?
MR. LUECK: In essence, Your Honor, they have agreed to provide us that information: A historical list of products going back to 1998, the identity of the module maker for each product and the LCD module number that is in the product.
THE COURT: All right. And is that really the heart of the dispute? Is there some other thing going on that I need to know about or is this really a kind of an Alphonse-and-Gaston thing about who goes through the door first?
MR. LUECK: Yes, I think that is correctly summarized, Your Honor. I believe if we can resolve this issue, we can make a lot of progress to resolving everything else.
THE COURT: Okay. Who wants to take this up in the first instance for the defendants?
MR. HORWITZ: Your Honor, this is Rich Horwitz.
I think that you have captured what the main dispute is and, really, it boils down to who should go first. Based on what Your Honor told us when we were in

front of you, I think we quoted the language from the transcript where we think it's their obligation to come first as the plaintiff charging infringement.

There may be some defendants who want to speak specifically because the burdens on defendants are different depending on how many products fall within the eight categories that were mentioned in the complaint for the time period that we're talking about here, to reach back and grab things for plaintiff with no firm charge of infringement. And I think that is the nub of the controversy.

There are some other issues that haven't been discussed yet today that plaintiff raised in its submissions and we responded to that we thought were outside the scope of what the Court ordered, but that is kind of a collateral matter to the main issue which is the one that you have been focusing on so far.

So if there are individual defendants, I think that they should be able to jump in at this point, if they want to add argument on their specific circumstances.

THE COURT: Okay. Who wants to speak? Don't be shy.

MR. GRAHAM: Your Honor, this is Barry Graham for the Nikon defendants. And I hope everyone can hear me well. I had to be on a cell phone today.

As Mr. Lueck acknowledged, which I appreciate,

that Nikon has resolved, has given Honeywell what it asked for. We gave them specific information in July, and the way I read the Court's May 18th order, Nikon and other customer defendants were under basically a conditional stay. And I would like, at least for Nikon, and there may be others, to ask the Court to change the conditional stay into a real stay while the other parties resolve their differences with the plaintiff.

THE COURT: All right. Does anybody else want to speak?

MR. ROSENTHAL: Your Honor, this is Lawrence Rosenthal for Fuji.

In fairness to the other defendants who still have this dispute, as you may recall, Fuji asked the Court to limit the case to the eight categories. Honeywell has now conceded that is what the case is limited to. And if the case is limited to eight categories, this case becomes a single product case for Fuji and the burden became finite and easy to satisfy. I think you will hear from other defendants that that is not the case.

THE COURT: Is there anybody else?

MR. RIZZI: Your Honor, this is Stephen Rizzi of Weil Gotshal for the Matsushita defendants.

Just to give you a sense of an example where we're not similarly situated to some of these defendants

like Nikon and Fuji, Matsushita is a very diverse electronics company and has products that span many of the categories. And if you literately consider going back six years, all LCD-containing products in those categories, there are hundreds, if not perhaps more than a thousand products in this action.

Honeywell has identified three products of Matsushita that are accused of infringement. We, months ago, told Honeywell who the LCD suppliers are for those products: two cell phones and one laptop. And just as sort of a fundamental matter of discovery and burden shifting, we don't believe that identification of three products justifies discovery of hundreds, if not perhaps a thousand products that may or may not be accused of infringement. The burden is squarely on Honeywell to identify which products they believe infringe and the case should be framed around those products. And we do not believe that merely identifying three products justifies essentially a fishing expedition into all products going backs six years which could number well into the hundreds, if not more.

THE COURT: Okay. I got you.

Does anybody else feel like they want to say something?

(Pause.)

THE COURT: All right. Hearing nothing,

Mr. Lueck, back to you. I'll give you a chance to rebut.

MR. LUECK: Thank you, Your Honor. Basically it's hard for me to understand how the burden could be greater on the defendants to provide this information than on Honeywell to go out and try to uncover every product that each of these defendants have sold in the past.

THE COURT: Well, wait. I've got to wrestle with you on that premise because at the start, I moved from the baseline understanding that the way our adversary system works is you learn of something that tells you you've been wronged and then you go and you draft a complaint that identifies that wrong and you come to court and you bring somebody in to answer for that wrong. So when you start by saying, gee, let's look at who has got the greater burden here, why is it the burden of defendants in the first instance to tell you everything they ever made with an LCD module in it when there's apparently a reluctance or unwillingness or inability on your part in the first instance to make a case that a product actually does infringe?

I'm probably giving away the way I'm thinking right now, aren't I? I'm having a real problem with the fundamental premise with your argument which is we think there is other stuff out there that infringes and we want to know everything you made in the last six years so we can

decide whether we got a case against you or not. That just isn't how it works.

MR. LUECK: Well, Your Honor, I believe we have made that showing. And what we have done is we've gone out and bought a large number of products from a wide range of customers or end manufacturing defendants. We've torn them down. We've given the defendants detailed information on what we believe is the infringement. We identified the eight product ranges where we found it.

The modules come from module makers overseas. We have no access to those individuals. And I think we've satisfied our Rule 11 burden, we satisfied the pleading burden on it, and then it becomes an issue of whether or not this is reasonably calculated to lead to admissible information, which we believe it is, and then it is an issue of looking at the relative burdens. And in our view on burden, we have a right to recover for damages going six years back from the date of the complaint. These models change rapidly and often. And we simply have no access to records that would show us what those models have been.

THE COURT: Well, let me ask this, because maybe we're talking past each other. When you say you have satisfied your initial burden, is the assertion that you are making that we have identified products, we've told them the products that infringe and the only question is whether,

through various generations of different models of this product, somehow there is some difference? Or is there something else going on that I'm not getting.

MR. LUECK: No, I think you have captured it. We've identified what the products are that have infringed and we've specified what those types of products are and we've given them specific model numbers as to ones we've been able to purchase and tear down, but that doesn't mean that we know all of the generations of those products that they have introduced in the past.

THE COURT: All right. I'm going to ask the gentleman who spoke on behalf of Matsushita, the Weil Gotshal attorney if he will speak up at this point and answer that point, which is: Hey, we're not just on some wholesale fishing expedition. We've identified a product and a product line and we just need to know the different model numbers in that product line so that we're sure that we've had a chance to investigate this product thoroughly, which is what I understand Mr. Lueck to be saying. What is your response to that?

MR. BRAFMAN: Your Honor, this is David Brafman from Honeywell.

I'd just like to add one further point which is our tear-down rate, on average it's about a 50 percent hit rate under our belief of infringement across all these

products. So it's not a wild fishing expedition as it is made to sound. It is that we found products, a large percentage of them do hit and we just don't have access to the models that change every six months.

THE COURT: All right. Mr. -- I'm sorry, I've forgotten your name, sir.

MR. RIZZI: It's Steve Rizzi from Weil Gotshal.

THE COURT: Mr. Rizzi, I apologize for not holding on to that name. Go ahead.

MR. RIZZI: That's okay. I think along those lines, Your Honor, there is room to meet in the middle here from our perspective and, in fact, one of the cases that Honeywell cited in its correspondence I believe is instructive -- the IP Innovation case out of the Northern District of Illinois -- I think is somewhat similar in the sense that case involved certain chips that were found in various models of televisions that were accused of infringement, the basis for infringement being this specific chip. And what the plaintiff did originally was identify specific television models that they believe included the chip and were infringing. And there, the Court allowed discovery of other models of televisions that included that same chip. So discovery in the case were structured around other future generations or products but only those products that included the same chip as the specific models

of televisions that were identified by plaintiff.

We think structuring it along those lines is reasonable and does provide a framework that does allow for a manageable case as well. And that we believe it is possible to identify, for example, other products that utilize the same LCD modules incorporated in these specific products that are alleged to infringe and that we don't believe that that would present an unreasonable burden, and we don't dispute that plaintiffs would be entitled to that type of information.

THE COURT: All right. Mr. Lueck.

MR. LUECK: Yes. What we asked for, Your Honor, is the modules that were identified in the infringing products and similar modules. And the problem we have is if you were to go to these module makers, some of the modules infringe, some of the modules don't. The module makers do not know what products they go into for the customers. Literally, the only way for anyone to find that out is to ask them for the historical products. And we've offered to take anything that they have and look at it and tell them whether it infringes.

I don't believe the burden is as great as the defendants are saying. We've narrowed it down to specific products we've torn down. We don't know all of the historical model numbers. That's the information we're

asking for.
THE COURT: All right.
MR. WILLIAMS: Your Honor, this is Rick Williams for Dell.
THE COURT: Yes.
MR. WILLIAMS: I'd like to weigh in on this. In the complaint, the products they're looking for include cellular phones, digital cameras, PDAs, portable DVD players, laptop computers. In the case of Dell, they identified six models of Dell laptop computers out of a total current 17 models.
The first thing, all of Dell's laptops are readily available to purchase over the Internet and they can get them within a week's time and evaluate them.
They have not identified any PDAs, which Dell also sells.
Dell resells digital cameras and digital video cameras. They have not identified any of those as being accused against Dell.
So we're faced with the dilemma, out of all these categories, they say they'd like information on --
THE COURT: We'll, we're not --
MR. WILLIAMS: -- them going down the list and giving them information.
THE COURT: Hold on. Because I get the feeling

we're still talking past one another here. Maybe positions have shifted as a result of the conversation we're having, but what I hear what Mr. Lueck is saying is not I want information about broad categories of products. I want information about a specific product identified and different generations of that same identified product. That is, has a model changed? And if it has changed, would you please identify what the newer different model is of that identified product? Not category of products but a specified product.
Mr. Lueck, have I misunderstood you?
MR. LUECK: Well, I think that is narrower than we seek, Your Honor. I mean if it's going to be tied to specific model numbers, we don't know what the past model numbers these devices are marketed under. Basically what we're asking for is which of your products had the modules that had the infringing technology or the similar technology in them so we can tie them back to the module makers and know what modules were imported into the United States.
THE COURT: All right. I interrupted.
MR. LUECK: That could be a different model number than what we have, we just don't know that, and we have no other way of finding out.
THE COURT: The gentleman from Dell, I interrupted you, sir. Go ahead.

MR. WILLIAMS: No, Your Honor. Again, they identified six models out of 16-17. They could certainly get the other models. Through the tear-down, they could purchase them as easily as Dell could absorb the expense and tell us the modules in fact they're accusing of infringement rather than asking us to go back and conduct a unilateral analysis of our products and say, well, maybe this module infringes or maybe this one doesn't. And I think the burden should be on them in the first instance to say a particular LCD module in a particular computer model we contend meets the elements of the claims in our patent instead of vice-versa.
THE COURT: All right. And I am going to have to get into a criminal proceeding here in a few minutes, so I won't have an opportunity to resolve other issues that you may have besides this one.
My understanding of what is being asked for has shifted a little bit in the course of this conversation. So instead of trying to speak in terms of what it is you are asking for, let me tell you what I think you can legitimately ask for and we can get this thing moving forward.
I said in the order that I put out last May that Honeywell was required to specifically identify accused products. And that's what I meant. Not that Honeywell was

entitled to say, you know, we think all your cellular phones infringe so we want you to tell us everything about all your cellular phones. What I mean is if you've got a basis for believing that a manufacturer's cellular phones are infringing, and I mean you can say we've done this tear-down on these specific products and these things appear to us to infringe, well, then you are absolutely entitled to conduct additional discovery with respect to those products, that is, were earlier generations than the one you tore down. Also, have they come out with subsequent generations of that same model which could also be infringing?
But what you are not entitled to do is to say you manufacture 15 different kinds of cell phones. We tore down three. Tell us about your other 12. Because I agree with the defendants that now what you are doing is you are telling manufacturers, you know what? You got one or two things that are bad. We want to you do an analysis of everything you make and tell us whether you are guilty on those fronts, too; and that is not what the law requires, and it's not what I'm going to require them to do.
If you want to go out, you want to buy them, you want to do the tear-downs, you want to get information that prompts you to be able to say "now I know that this specific model also infringes," then you can certainly do that. And then you would be in an area where you could be requiring

additional discovery from them. But to ask them to come forward in the first instance, which is what it really comes down to, is not right.

So I hope this straightens out where my thinking is on it and gives you guidance about what I'm expecting the parties to be willing to do. To the extent manufacturers are prepared to say, you know what? For us, it's not such a burden as to make it impossible to give you something more broad than what the judge has ordered happen, that is fine with me. But what I do expect to happen at this juncture is for you guys to come together with a specific set now of identified products and manufacturers of the models of LCD modules that go into those products so that we can go about having the proper defendants in the suit.

To the extent there was any thought that I was putting the burden exclusively on the defendant retailers or intermediate sellers, to third-party people in, that is not necessarily the case. I'm not going to get to that issue today, though, because we don't have time to fully explore it, but I expect Honeywell to be active in finding out who those manufacturers are and that is one of the reasons why I gave only a conditional stay, because one of the pieces of information Honeywell is entitled to get as to those identified products and product lines is who is the maker of the LCD that is going in to that product, that generation of

product and maybe, I don't know, the generations before and after that model.

So you guys absolutely on the defense side have to give that information up. And then if we can't have some sensible plan that the parties agree to on how to try to bring those folks in, I'll get into the mix on that, too. I would think that overseas marketers of LCD modules who have big clients in the United States incorporating those things into their products are not going to want to upset their clientele by playing games with jurisdiction. And particularly in the aftermath of the Federal Circuit's CEA decision, which I remember well, I would think people would be thinking hard about how they're going to play the personal jurisdiction defenses here. But that is a discussion for another day.

For now, I want you to get off of the who-goes-first issue because Honeywell you guys are going first. You identify what is infringing. Let's get those manufacturers on notice and let's get the case going forward.

When can I expect to hear back from you about a plan for getting that done, Mr. Lueck?

MR. LUECK: Within a week, Your Honor. If I could ask for just one clarification, recognizing you have something else going.

The issue that we've had is just identifying who the manufacturers of the modules are that are coming into the U.S. And hearing what Your Honor has said regarding those modules, can we ask about historical products that have those modules or similar modules in them?

THE COURT: Well, when you say the "same" or "similar," you know, the "same," absolutely. When you say "similar," that is a big door, because, what do you mean when you say "similar?"

MR. LUECK: Right. Here is what I mean when I say "similar," Your Honor. A light source, an LCD panel, two lens arrays, one of which is misaligned.

THE COURT: If you want to say, if you want to frame your discovery in a manner that incorporates your specific allegations of infringement, fine.

MR. LUECK: That is exactly what we're asking for. And that we would frame it exactly that way.

THE COURT: All right. Does everybody understand the discovery I'm telling them they're entitled to?

(Pause.)

THE COURT: I'm not hearing anybody say no.

MR. HORWITZ: Your Honor?

THE COURT: Yes, go ahead.

MR. HORWITZ: This is Rich Horwitz. And I'll

defer to others if I'm missing something here, but I think the problem with what Mr. Lueck just said is he may be asking for things that led us to the stay motion in the first instance.

THE COURT: No. What led to the stay motion in the first place is I'm not going to have the folks who are reselling things, reselling the LCD module as a part of their own product defending in the first instance.

MR. HORWITZ: I'm sorry. I understand that, Your Honor. What I meant was that some of the people that are the resellers may not have the information that would respond to the broad question that Mr. Lueck just posed.

THE COURT: Well, and if you don't have it, you don't have it.

MR. HORWITZ: Okay.

THE COURT: I mean I'm not saying anybody has to make anything up, but if you've got the information, you need to give it up because they're entitled to get behind your products and get it to people who are making them if they can get jurisdiction over them. And that's all.

Like I said, the personal jurisdiction issue, that's for another day. But finding out who the manufacturers are, that's something that is supposed to have been happening over the course the last four months and it's distressing to hear that we've been not moving forward on

that front because we should be. We should be finding out who this case is going to run against in the first instance. So I'll ask the parties to move forward with that forthwith; all right?

And, Mr. Lueck, I'll look forward to hearing from you some time in the next few days in a fashion that includes discussions to the extent you need to have it with all defense counsel on how you folks intend to proceed so that I can get a scheduling order in place.

I'm going to set a deadline on you folks reporting back to me for two weeks from today; all right? And hopefully that can be a joint submission. But if it can't given, the number of parties involved, it may be impracticable, I'll expect though to hear from everybody with a position on scheduling because what you can expect from me is I'm ready to put an order in place. I want to get a schedule in place. So you should be talking about how to make that happen.

All right. Is there any other matter which is of such urgency we ought to address it right now while we're all on the phone right now, Mr. Lueck?

MR. LUECK: No, Your Honor.

THE COURT: From the defense side, anything?

MR. HORWITZ: No, Your Honor.

THE COURT: Okay. I'm hearing --

MR. GRIMM: Your Honor?

THE COURT: Yes.

MR. GRIMM: Your Honor, this is Tom Grimm.

I do have a concern of letting this go on and on because we've had such a hard time in the last three or four months. And this has been very helpful to us but I'm wondering if we could bother the Court for your permission that in two weeks after we report, if there is still differences, can we contact your clerk and ask for another telephone conference?

THE COURT: Well, that is something you are always free to do. If there is a problem in the case that I can help you work out, I'm ready to help you work it out. But I'm fully expecting on the basis of the discussion we just had, for you to be able to take the next step, which is set a schedule for getting this case transitioned to an infringement suit against the manufacturers. All right?

MR. GRIMM: All right.

MR. GRAHAM: Your Honor, this is Barry Graham for Nikon.

Nikon would like to be able to step aside. Do we need to participate since we already provided the information to Honeywell?

THE COURT: The short answer is if Honeywell and you agree that you don't have anything else to say with

respect to the case, I'm not going to default you. And at a certain point in time, there will be a transition from a conditional stay to a full stay but I don't want to handle that on a defendant-by-defendant basis if I can help it, so I'm not moving on that request that you made earlier in this call at this time.

MR. GRAHAM: All right. Thank you, Your Honor. I'll speak with plaintiffs' counsel.

THE COURT: All right. Well, thanks for your time this morning. Good-bye.

(The attorneys respond, "Thank you, Your Honor.")

(Telephone conference ends at 11:18 a.m.)

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